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Key SketchUp Plug-in Tools

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Interactive PDF

Introduction

Notes

The basic workflow for OpenStudio starts in the SketchUp Plug-in creating the building envelope and assigning space attributes.

Next, the model is loaded in the OpenStudio application, shown on this page. You can step through the tabs from top to bottom. For a basic workflow the resource tabs and many others are not necessary. A minimum workflow is shown in the box below.

This PDF is an interactive guide. Click on the SketchUp Plug-in icons above or the major tab icons at the right to jump to the appropriate pages. Subtabs. menu items, and pink labels can also be clicked to jump to another view.

Minimal Workflow Through OpenStudio Application

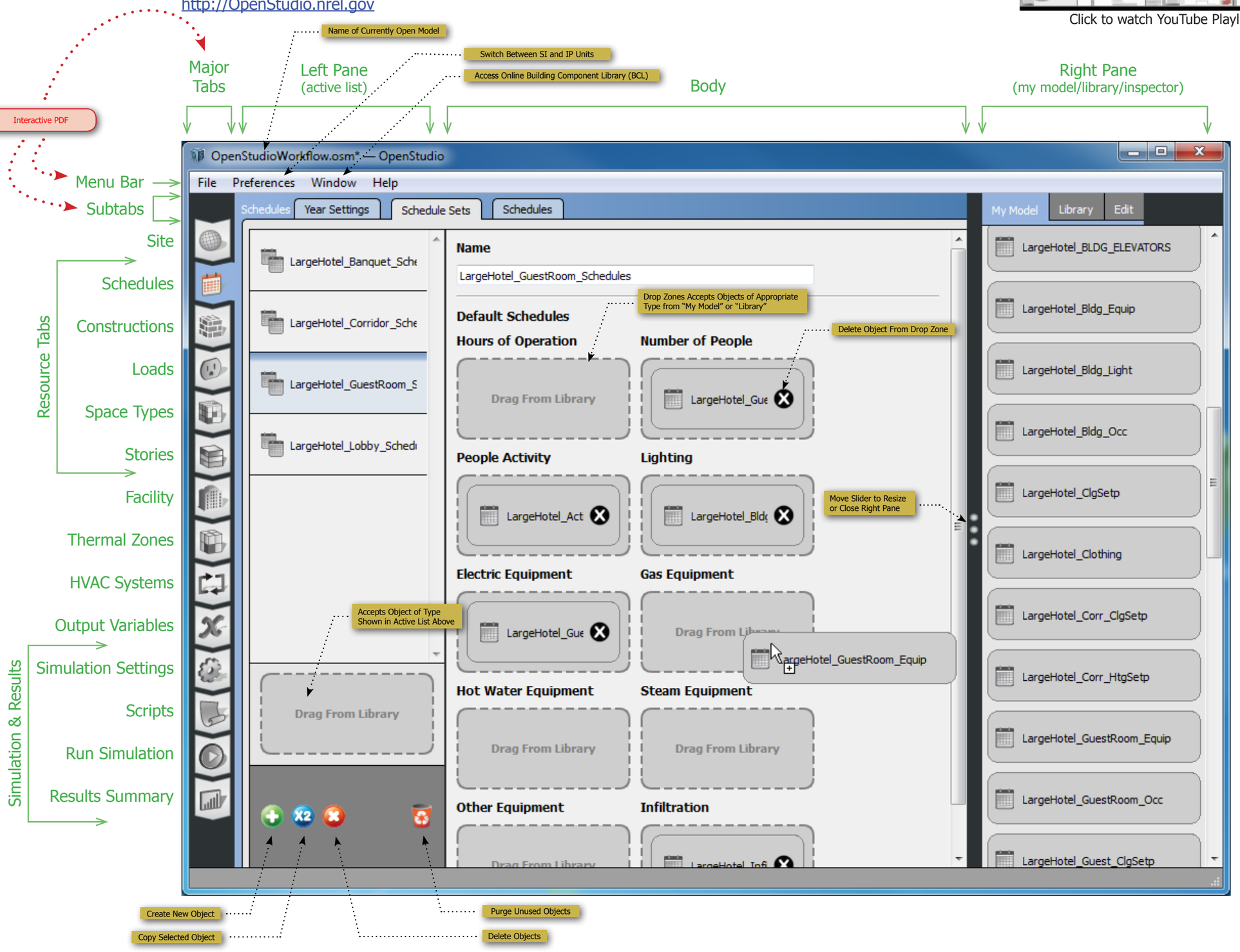
Site

Thermal Zones

HVAC Systems

Run Simulation

Results Summary



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SketchUp - Choose Template

Notes

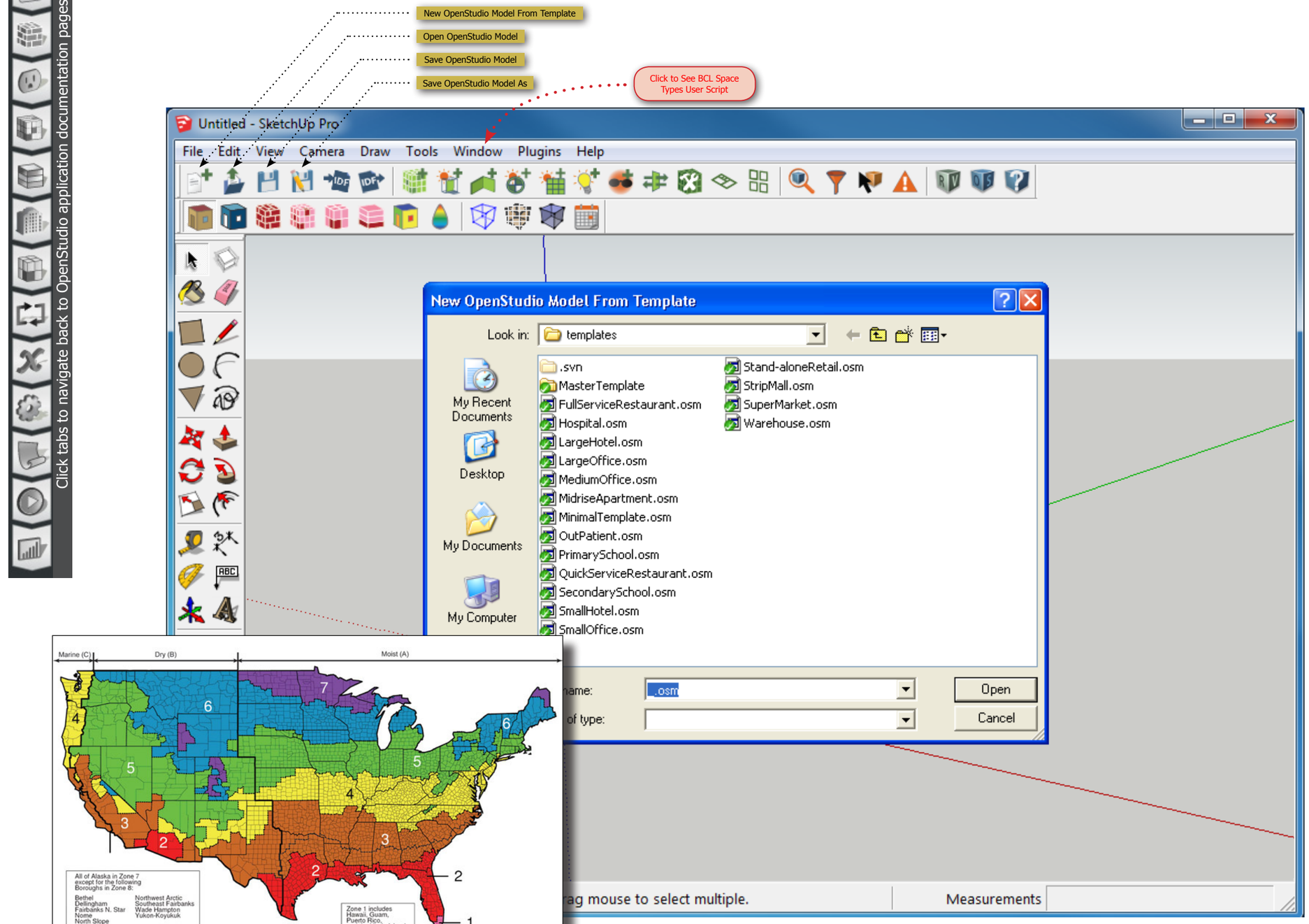
Each of these building type-specific templates are loaded with construction, schedule, and internal load data for Various vintages and for all U.S. climate zones.

If you plan to apply attributes only in the OpenStudio application, you can use the minimal template, which is the default when you first install OpenStudio. You can also use the "Get BCL Space Type" user script to generate and download spaces types into your current model.

Vintages and Climate Zones

Vintages:
CBECS Before 1980
CBECS 1980-2004
ASHRAE 901.1-2004
ASHRAE 189.1-2009

Climate Zones:
1-8 (see map)



Key SketchUp Plug-in Tools

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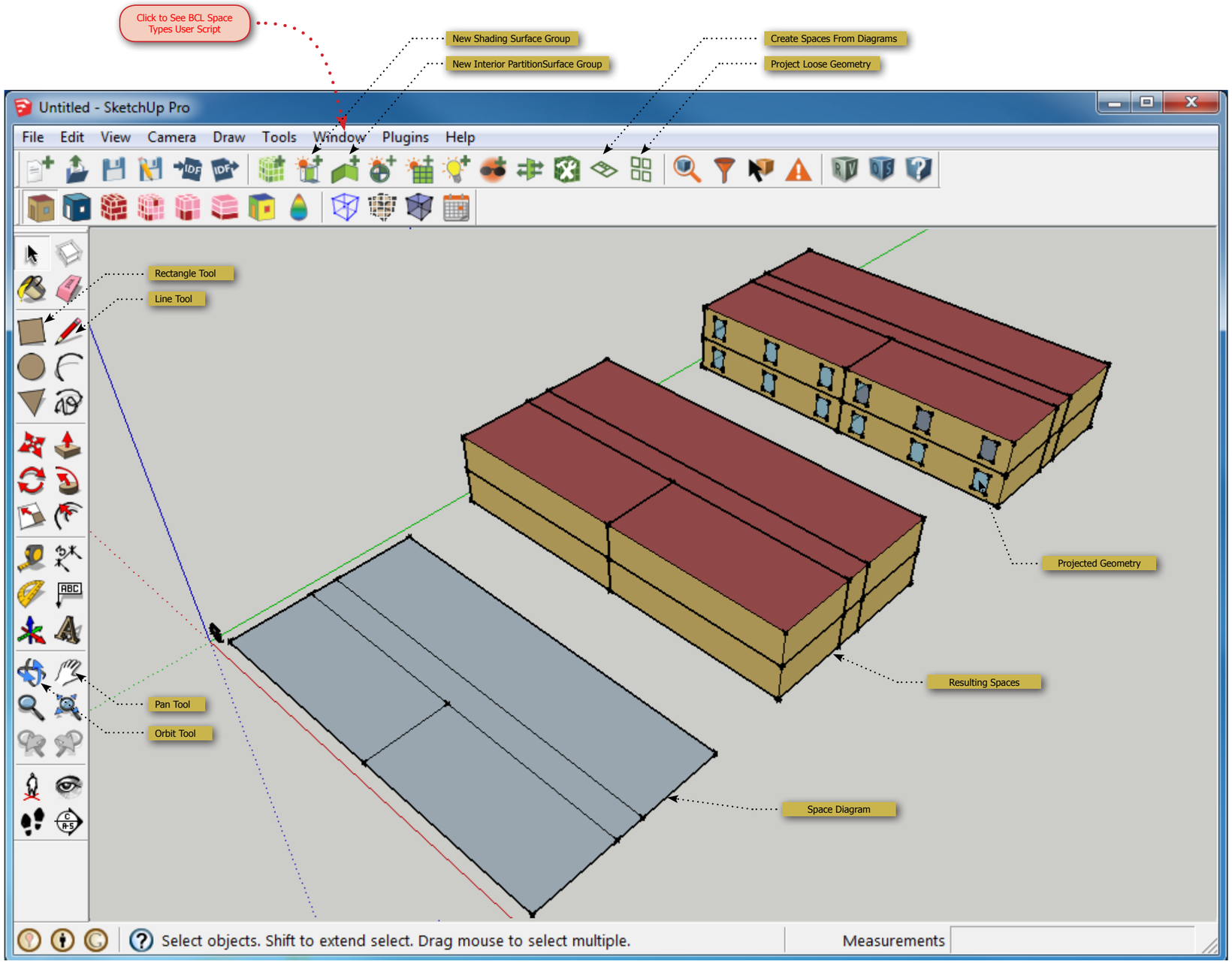
SketchUp - Building Envelope

Notes

After using native SketchUp tools to draw a space outline, you use the Spaces From Diagram tool to project the diagram into a multistory building. Although the geometry is automatically generated from the diagram, you can edit it using standing SketchUp Tools.

You can take a similar approach for fenestration. Again draw loose geometry with native SketchUp tools, but this time use the Project Loose Geometry tool to apply the fenestration to the appropriate spaces. Optionally use the user scripts to create windows based on window to wall ratio or project overhangs based on a projection factor.

You can create additional model geometry using the Shading Surface Tool and the Interior Partition Surface Tool. Spaces can also be imported from gbXML.



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SketchUp - Surface & Space Attributes

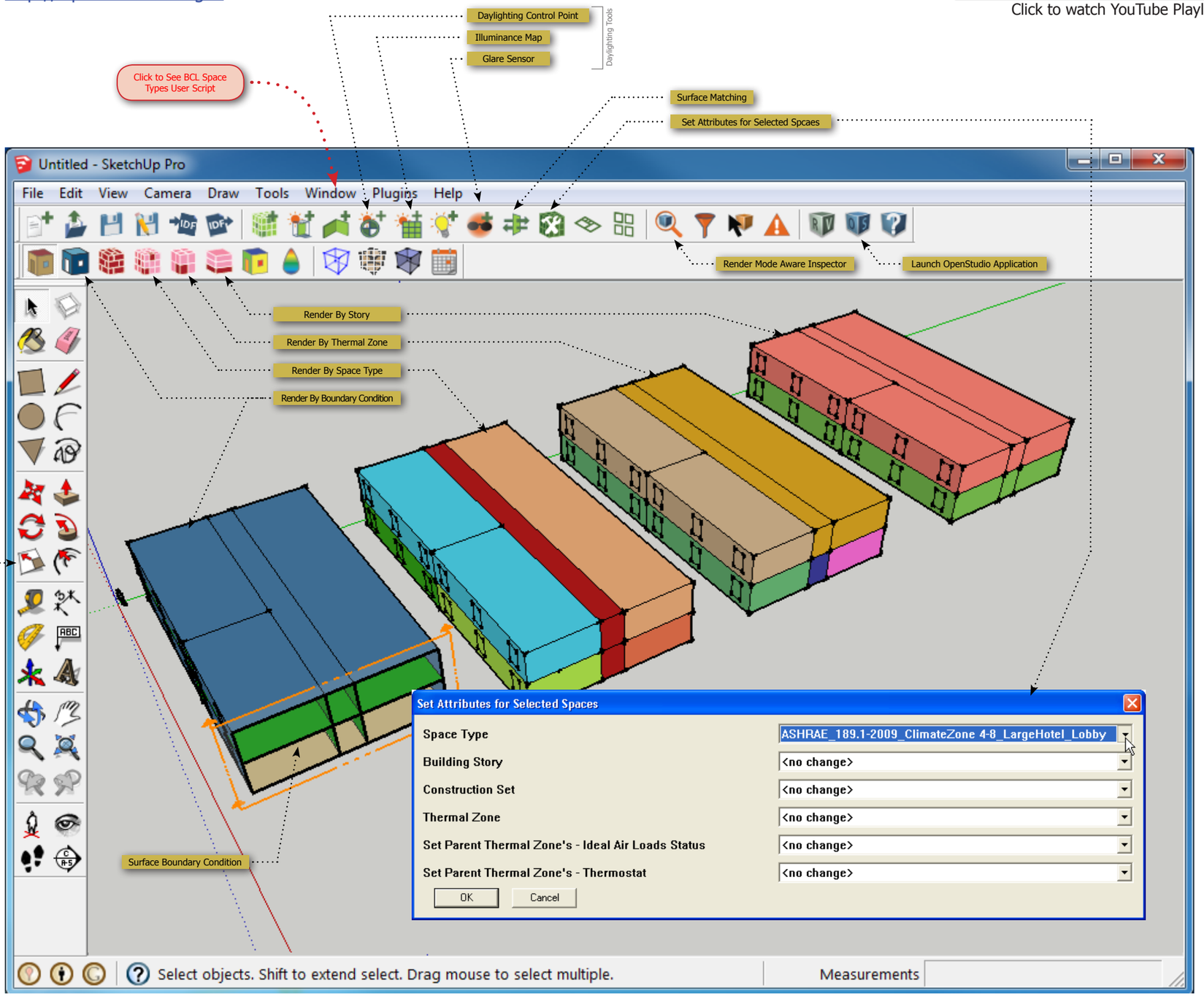
Notes

After defining the building envelope, you use the Surface Matching tool to set the boundary conditions. These will allow thermal connections between spaces and will inform OpenStudio about what construction to apply.

Then you can use the Space Attributes tool to assign various attributes to a space. There is a matching render mode for each space attribute. To apply space attributes, select one or more spaces, and then click the Space Attributes tool.

The image to the right shows a composite of the same model viewed in different render modes. In practice your entire model will render in a single mode at a given time. This example is just to demonstrate the render modes side by side.

To run your simulation click the OpenStudio button to Launch your model in Open-Studio and then go to the Run tab.



Key SketchUp Plug-in Tools

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SketchUp - User Scripts (BCL Space Type)

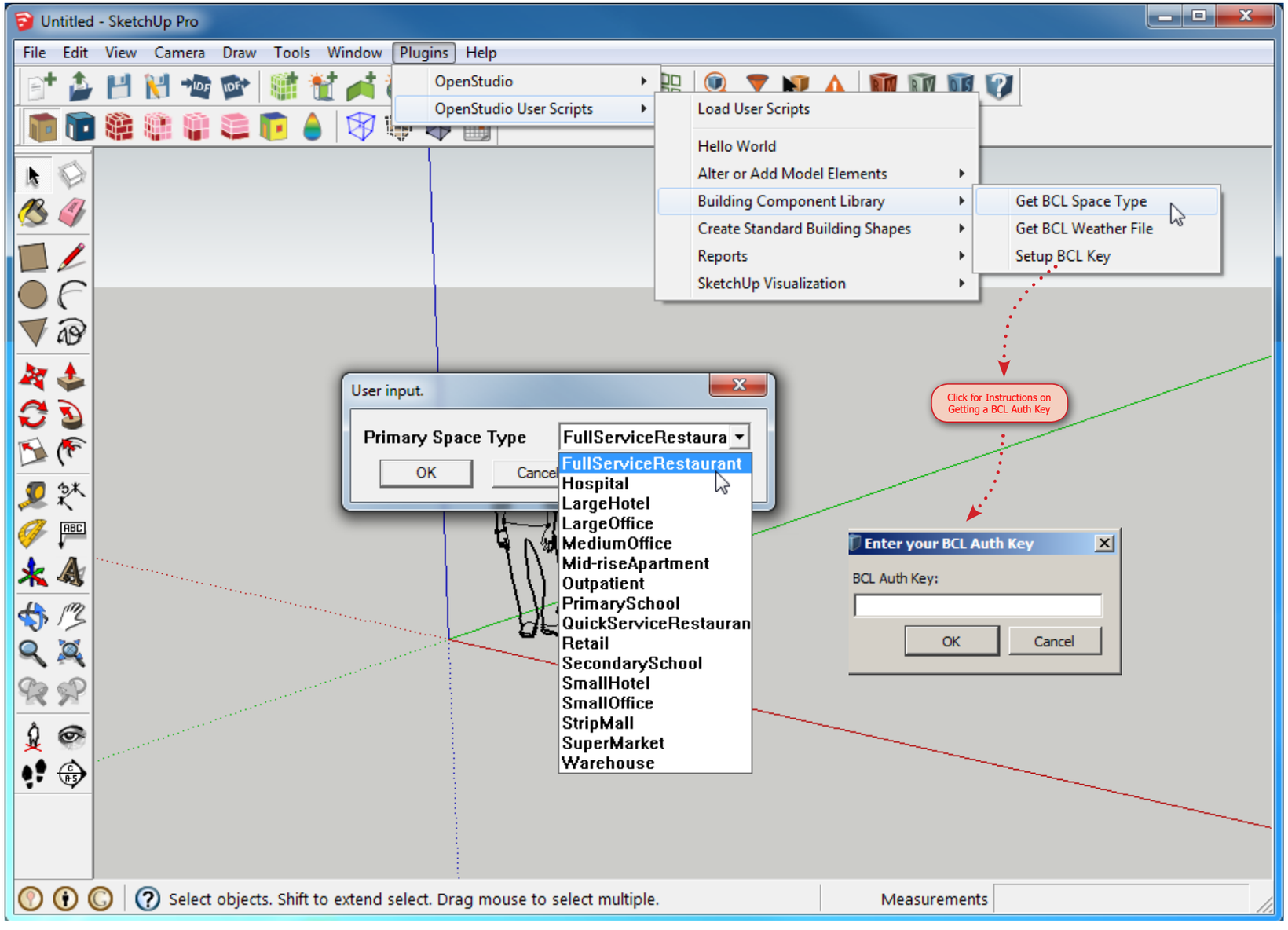
Notes

"Get BCL Space Type" will dynamically create OpenStudio spaces types from data on the Building Component Library (BCL) website based on user input related to vintage, climate zone, and building type.

The first time you request a specific combination of inputs it will take some time to download the component. The components are saved to your local database; they don't have to be downloaded next time you make the same request.

The first time you use this script or any other BCL functionality you will be prompted for a BCL API key. This PDF has a page that provides instructions on obtaining a BCL key.

The user scripts menu contains many other additional example scripts.



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File Menu

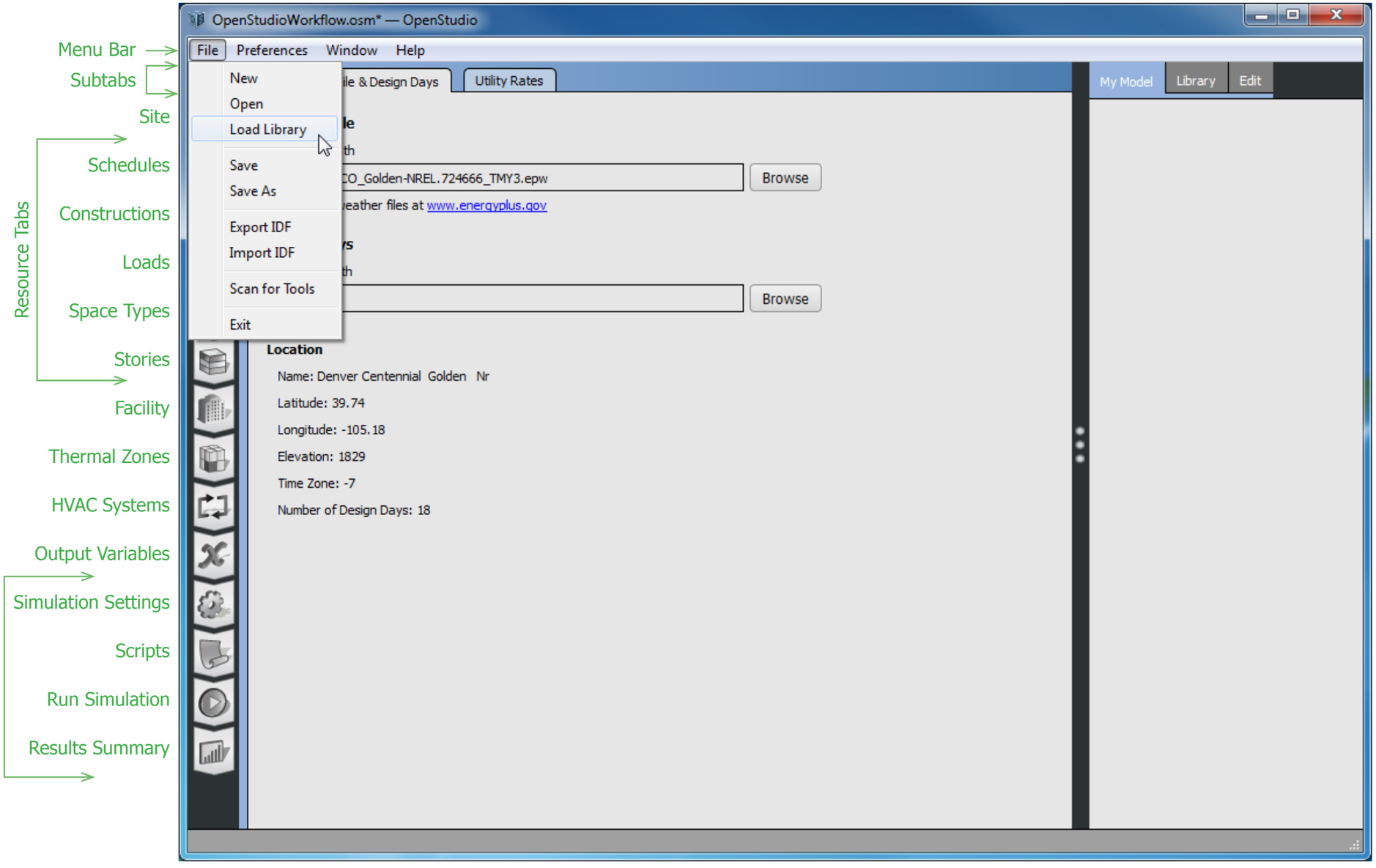
Notes

If you launch the OpenStudio application from the SketchUp Plug-in, your open file will automatically open in the application. But to save the file or open a new file, select file open from the menu.

When you save an OSM model in the OpenStudio Applica-tion or the SketchUp Plug-in a folder is saved next to the OSM file. This folder contains external resources such as the weather file, scripts, and simulation results.

Load Library is also a very important feature. This allows you to load building com-ponent libraries for specific building types. These libraries are the same as those used in the SketchUp Plug-in tem-plates.

Scan for Tools will look for Radiance, Ruby, and Ener-gyPlus installations. If you install those applications Prior to installing OpenStudio this shouldn't be necessary.



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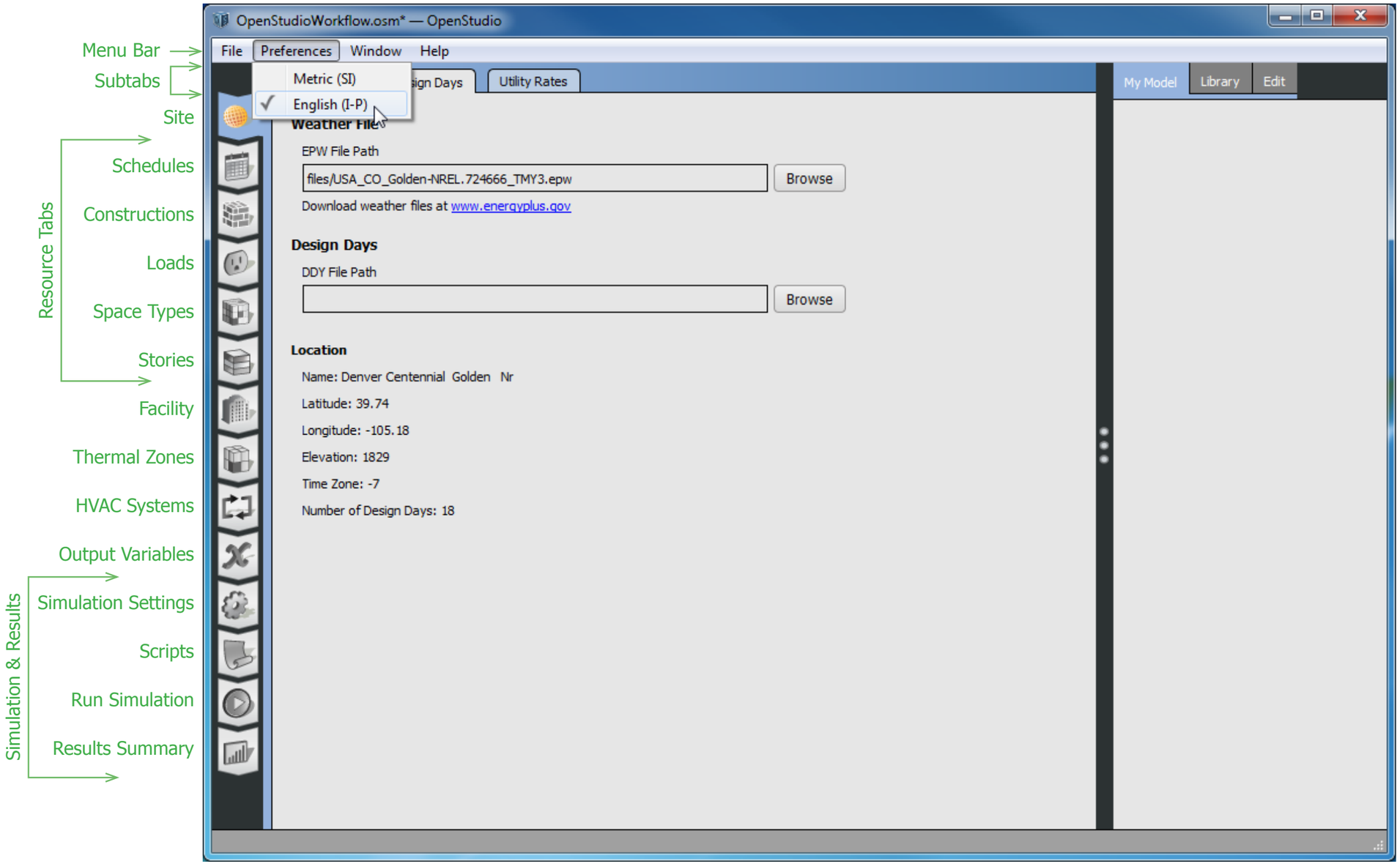
Preferences Menu

Notes

The Units menu lets you switch between SI and IP units. This affects both input fields and output data on the results tab. It does not currently affect standard EnergyPlus output files.

The SketchUp Plug-in has access to this as well under "Plugins/OpenStudio/Preferences".



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(BCL) Window Menu

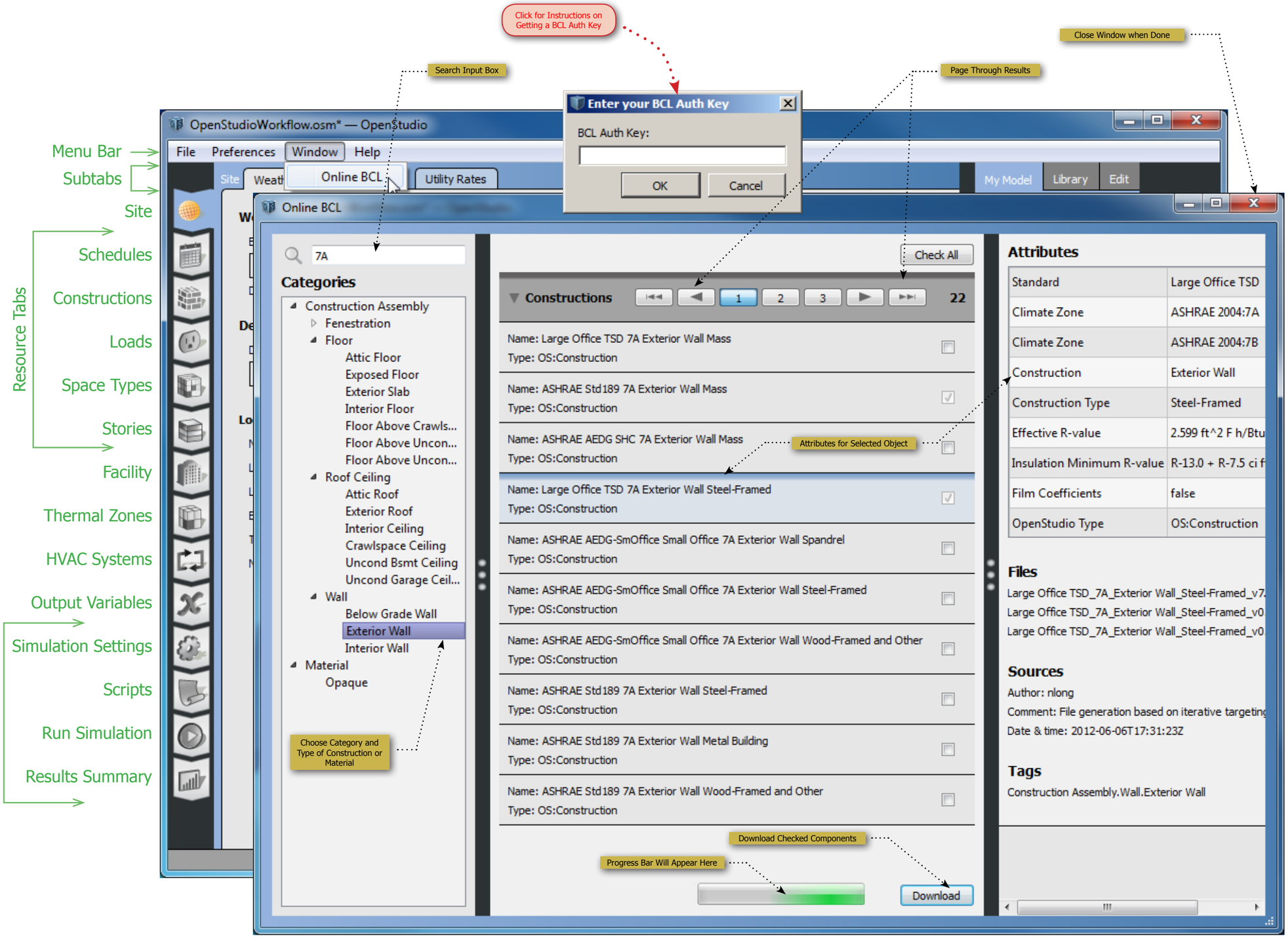
Notes

The BCL window gives you access to an online repository of building energy modeling data called the Building Component Library. Although you can access the BCL website on its own, OpenStudio has integrated access to the BCL from within the application. You can access this through the "Window" menu.

The first time you open this window you will be prompted for an API key, unless you have already used BCL functionality in the SketchUp Plug-in.

The Online BCL window currently exposes construction and material objects. You can choose a category and you can also search for a text string. Next you can check and download one or more of the resulting components. The pane on the right shows attributes for the currently selected component. Once downloaded, these components are stored in a local database on your computer.

Within OpenStudio, components downloaded from the BCL have visual tags to indicate their origins.



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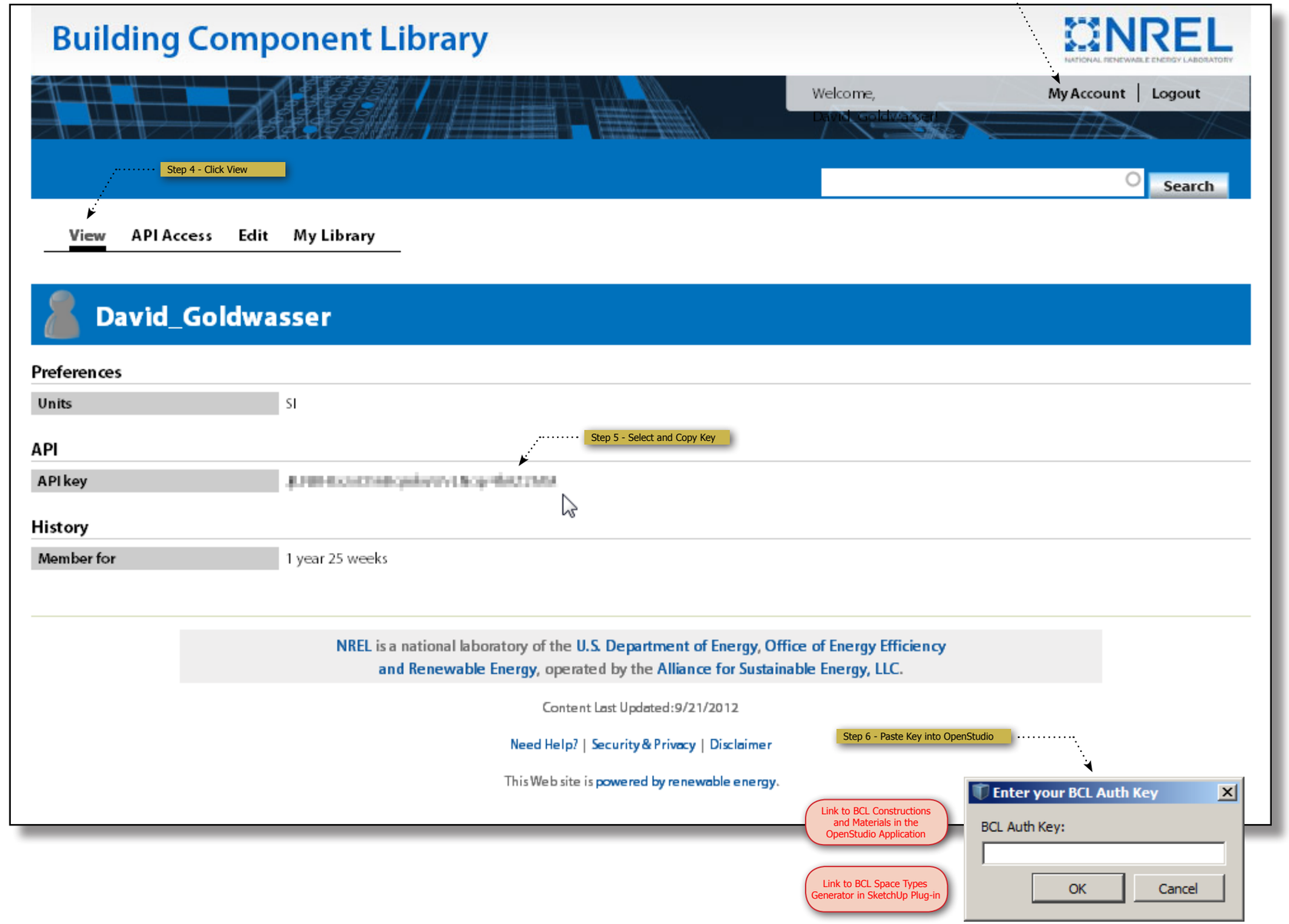
https://bcl.nrel.gov

Notes

To use the BCL features in OpenStudio, you need to register on the Building Component Library website and setup an "API Key." This is a separate site from the OpenStudio website. The steps to setup an account and obtain a key follow.

1. Go to https://bcl.nrel.gov/user/register and follow the registration instructions.
2. Check your email for the confirmation to activate your account, then login.
3. Click "My Account."
4. Click the "View" link to see your key
5. Select and copy the Key.
6. Return to OpenStudio and paste the key into the input box.

Your key will be remembered when you Upgrade OpenStudio so you should only have to do this once, unless you get a new computer, then you will have to go through steps 3-6 to retrieve your key.



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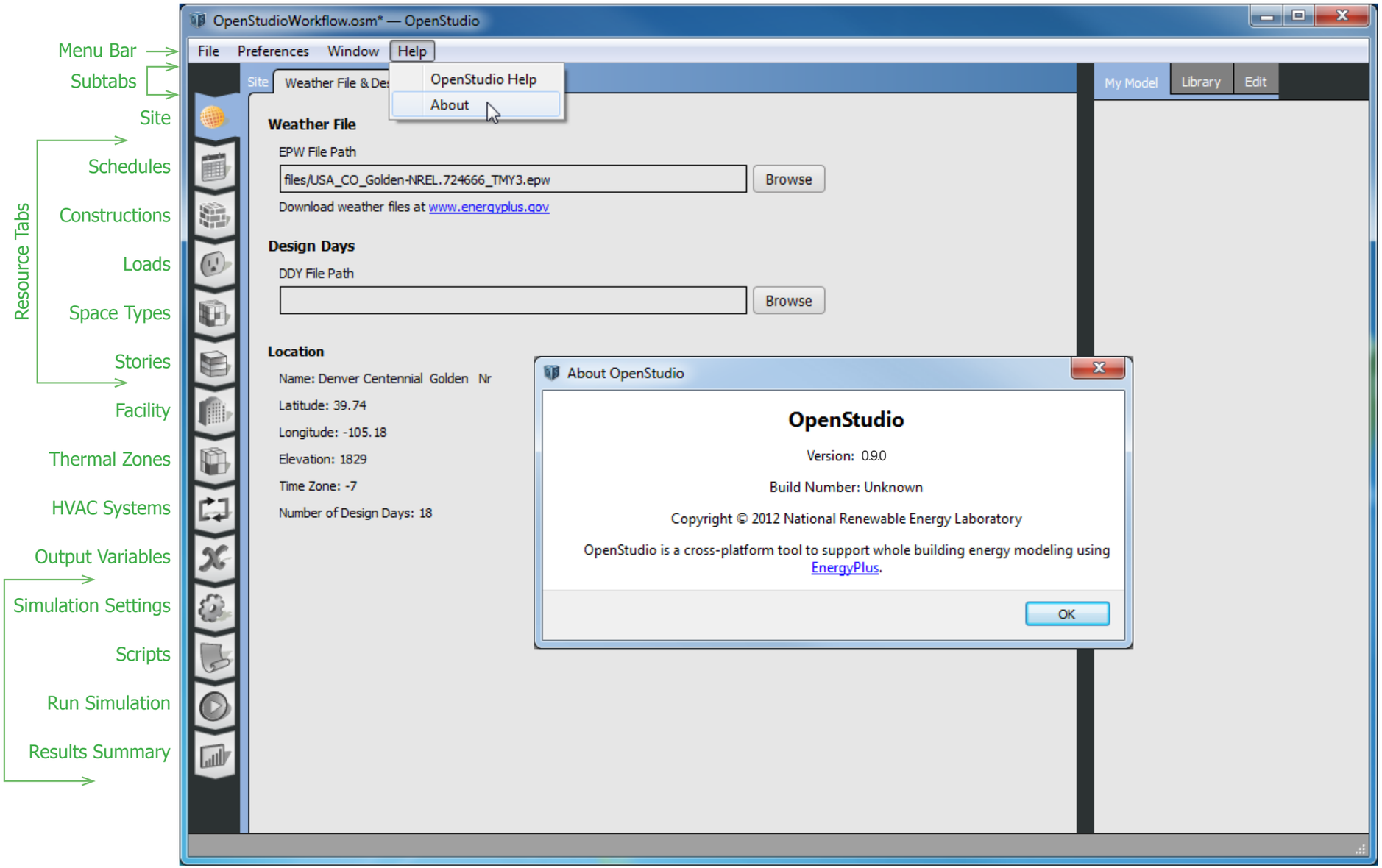
Help Menu

Notes

The help menu can take you to the OpenStudio website or open a window that provides details about your installation of OpenStudio.



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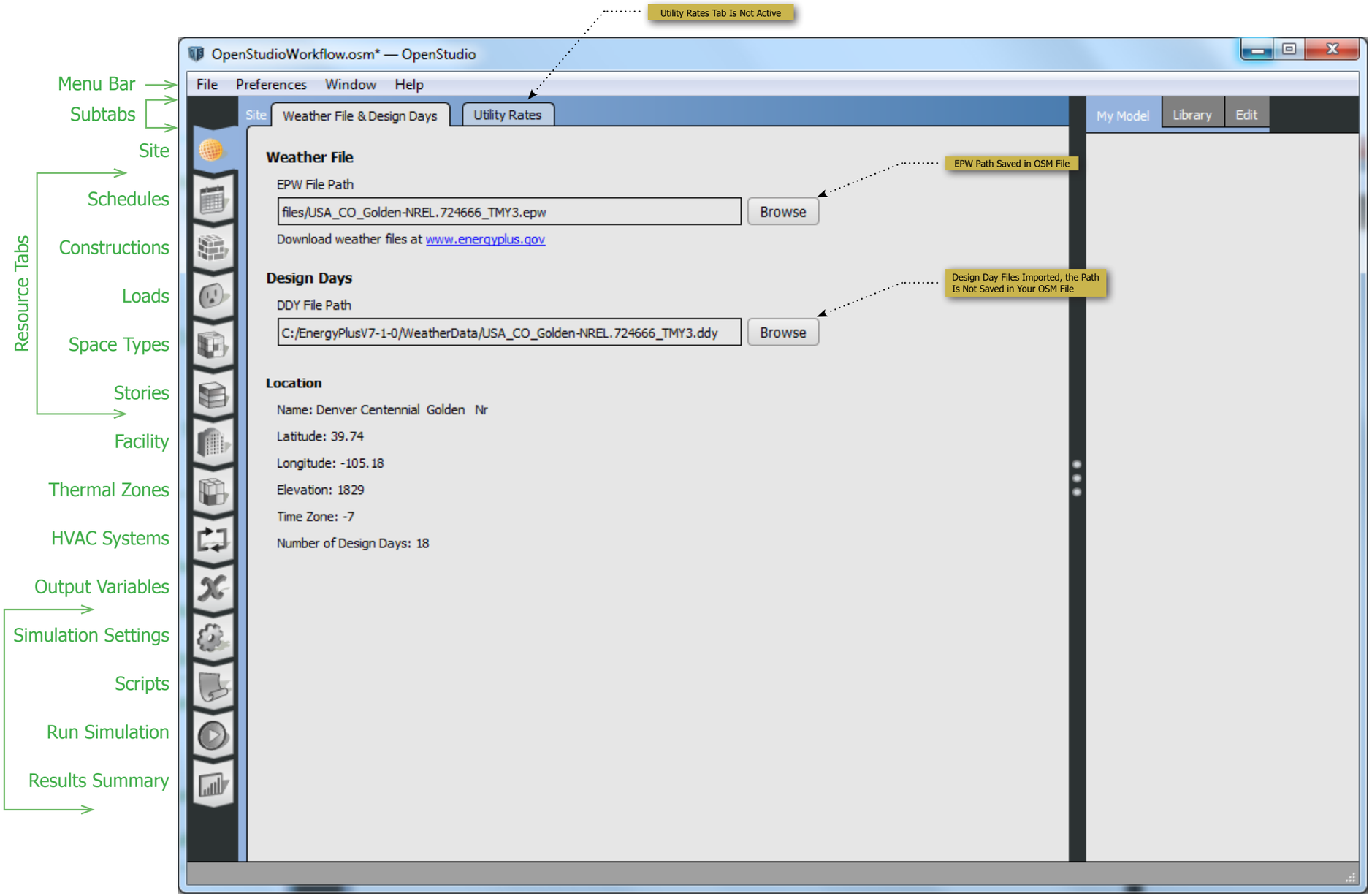
Site - Weather File & Design Days

Notes

The Site tab allows you to set the path of the EPW weather file that you want to use for your simulation and for loading design day files.

The weather file is stored in the OSM file as a path. When you reopen a model you will still see that path displayed. Design days are a little different. They are loaded into your model. The path they were loaded from is not saved, so when you reopen your model you will not see a path in the DDY file path box.

The Utility Rates subtab is not yet functional. For this release you can use the "ImportImfSection.rb" script in the Scripts tab to load these.



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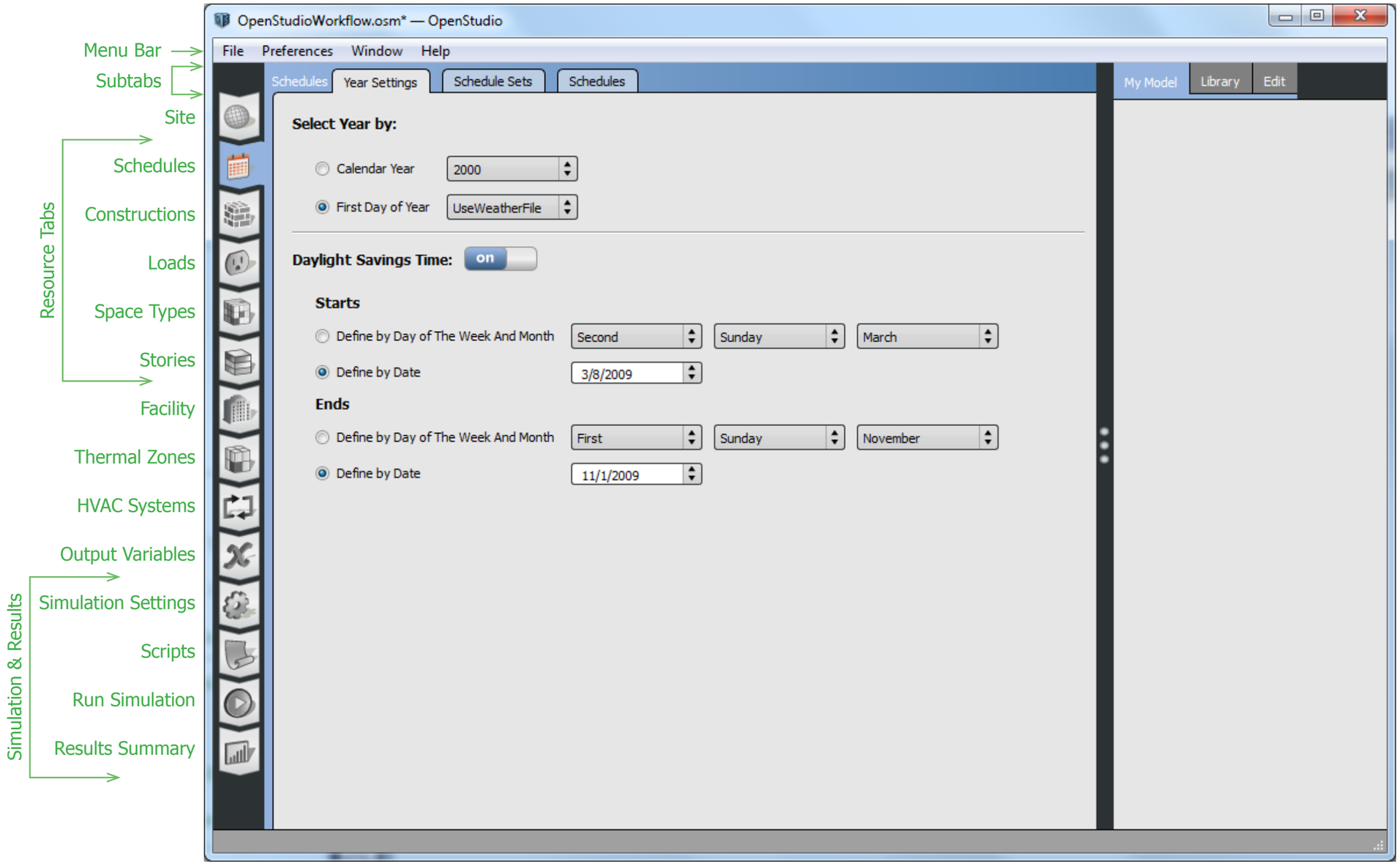
Schedules - Year Settings

Notes

The Year Settings subtab lets you set the day of the week the simulation should start. Define using Calendar Year or First Day Of Year buttons and pull-downs.

The tab can also be used to configure and turn Daylight Savings Time on and off.



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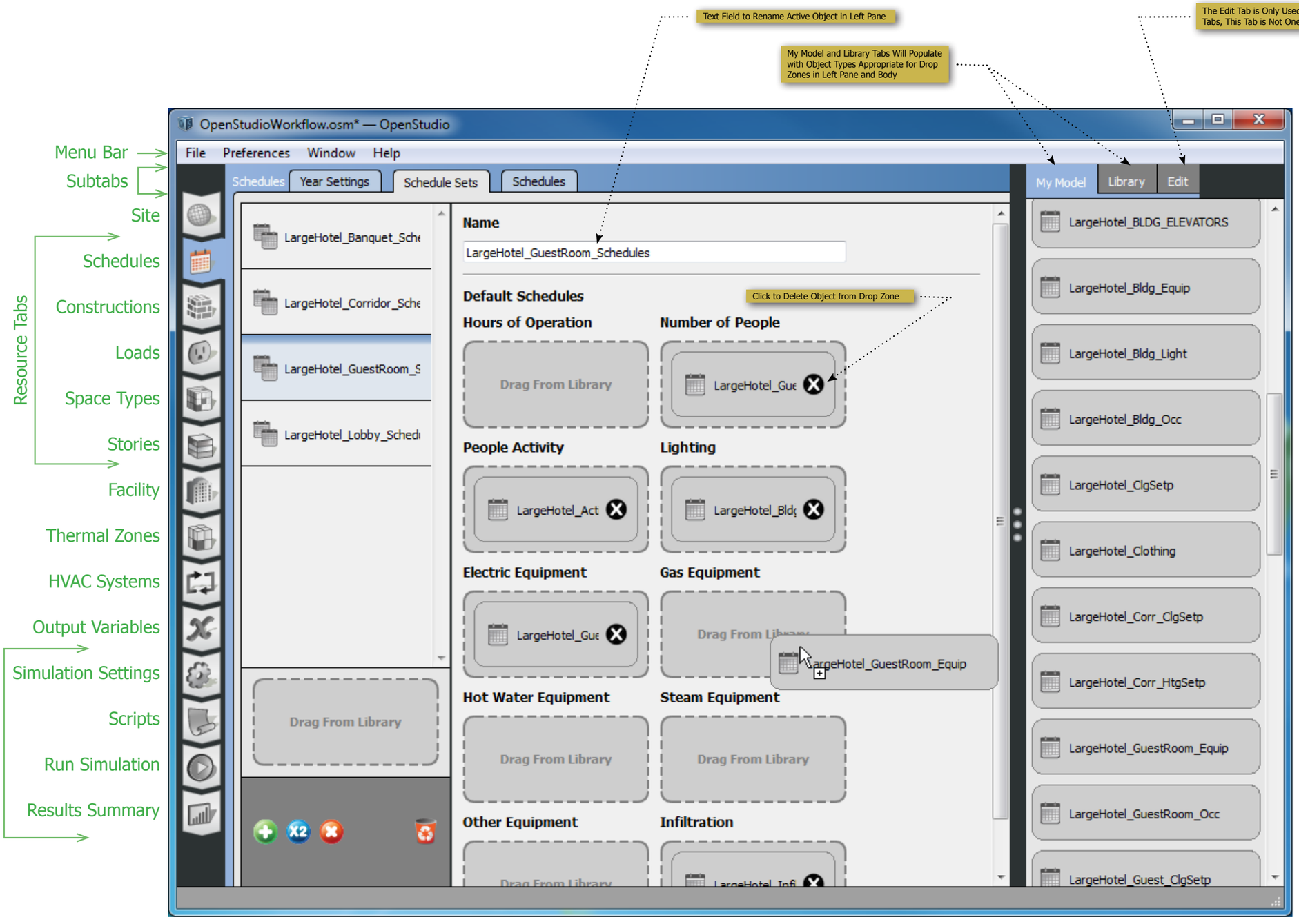
Schedules - Schedule Sets

Notes

A Schedule Set is a collection of schedules for building activities or elements.

A schedule set can be applied to an entire building, a story, a space type, or an individual space.

This subtab has two kinds of drop zones. You can drop schedule sets from My Model or Library into the bottom of the left pane, or you can drop individual schedules into the drop zones in the main body.



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Schedules - Schedules

Notes

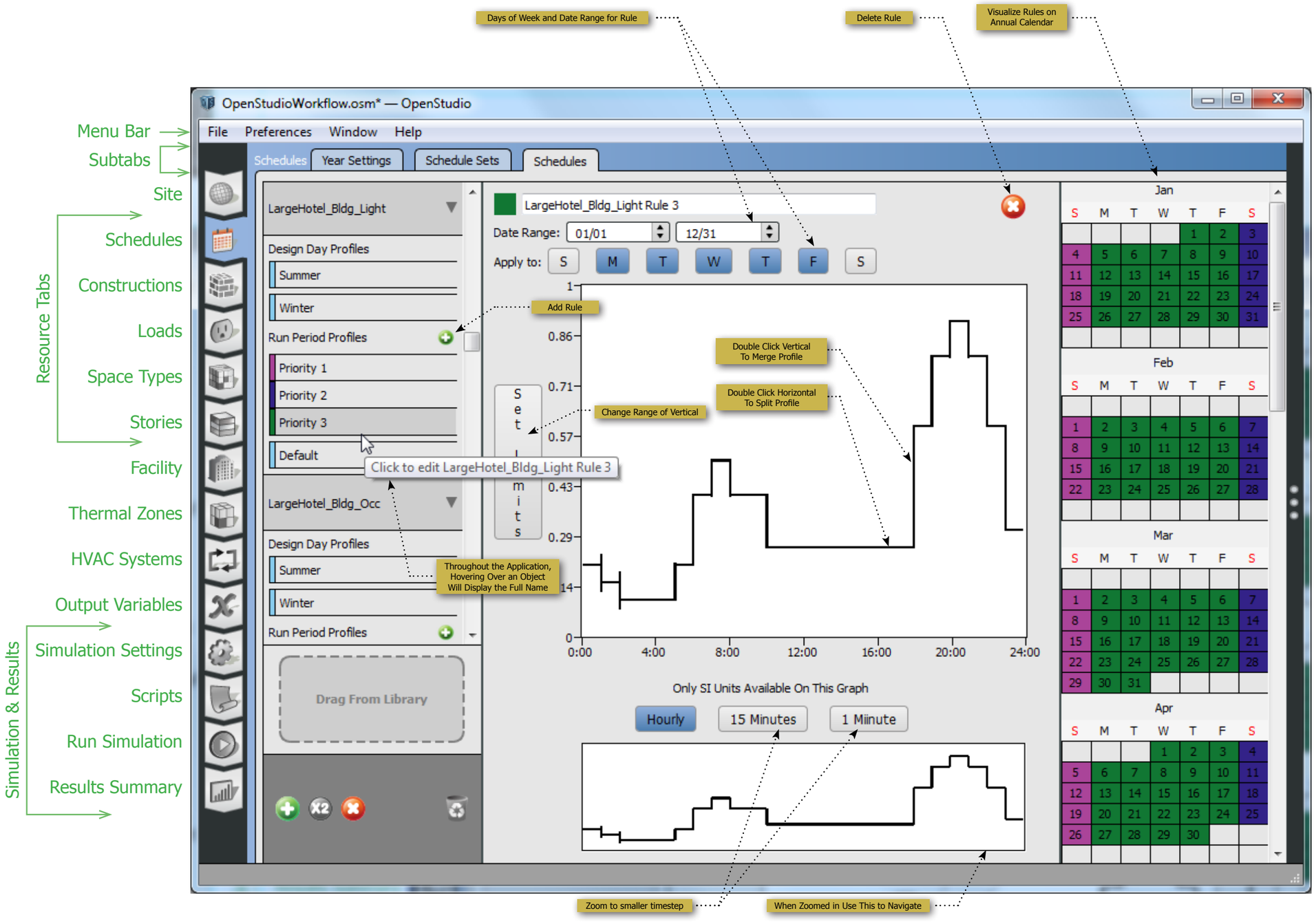
This tab is a visual editor for Ruleset Schedules. As the name implies, a schedule consists of a series of rules. Each rule or profile can be applied for a specific date range and for specific days of the week.

If two rules appear on the same day, the one with a higher priority is used. You can use the rule colors to visually scan the entire year in the calendar on the right of the body to see what rule is applied for a specific day.

A new profile starts as a flat line. Double click to split the profile and then drag one segment up or down. Vertical sections can also be dragged left or right. Click Set Limits to change the vertical limits of your profile. To type precise values for a profile, mouse over the profile and enter a value with your keyboard.

Although you can use Compact and other schedule types in your model, you can visualize and edit only Ruleset Schedules in the OpenStudio application.

The lower profile view is a navigation for when you are zoomed to 15-minute or 1-minute time steps.



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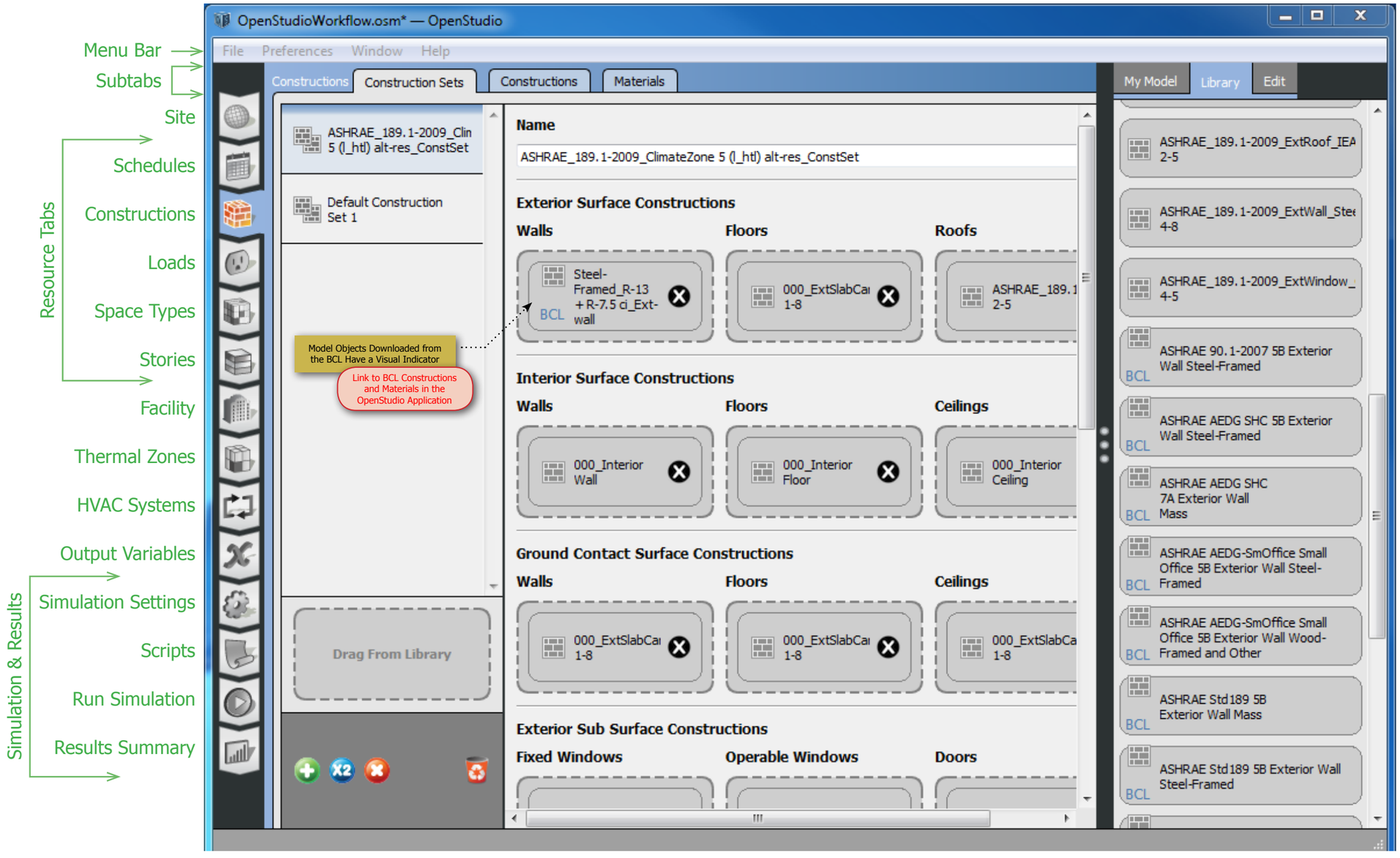
Constructions - Construction Sets

Notes

A Construction Set object is structured very much like the Schedule Set. It can contain constructions for different surface types and boundary conditions.

A construction set can be applied to an entire building, a story, a space type, or an individual space.

Construction sets do not have to be complete sets. For example, you can have a construction set assigned to a story that has only an exterior wall. For the rest of the surface types, constructions will be inherited from the building object.



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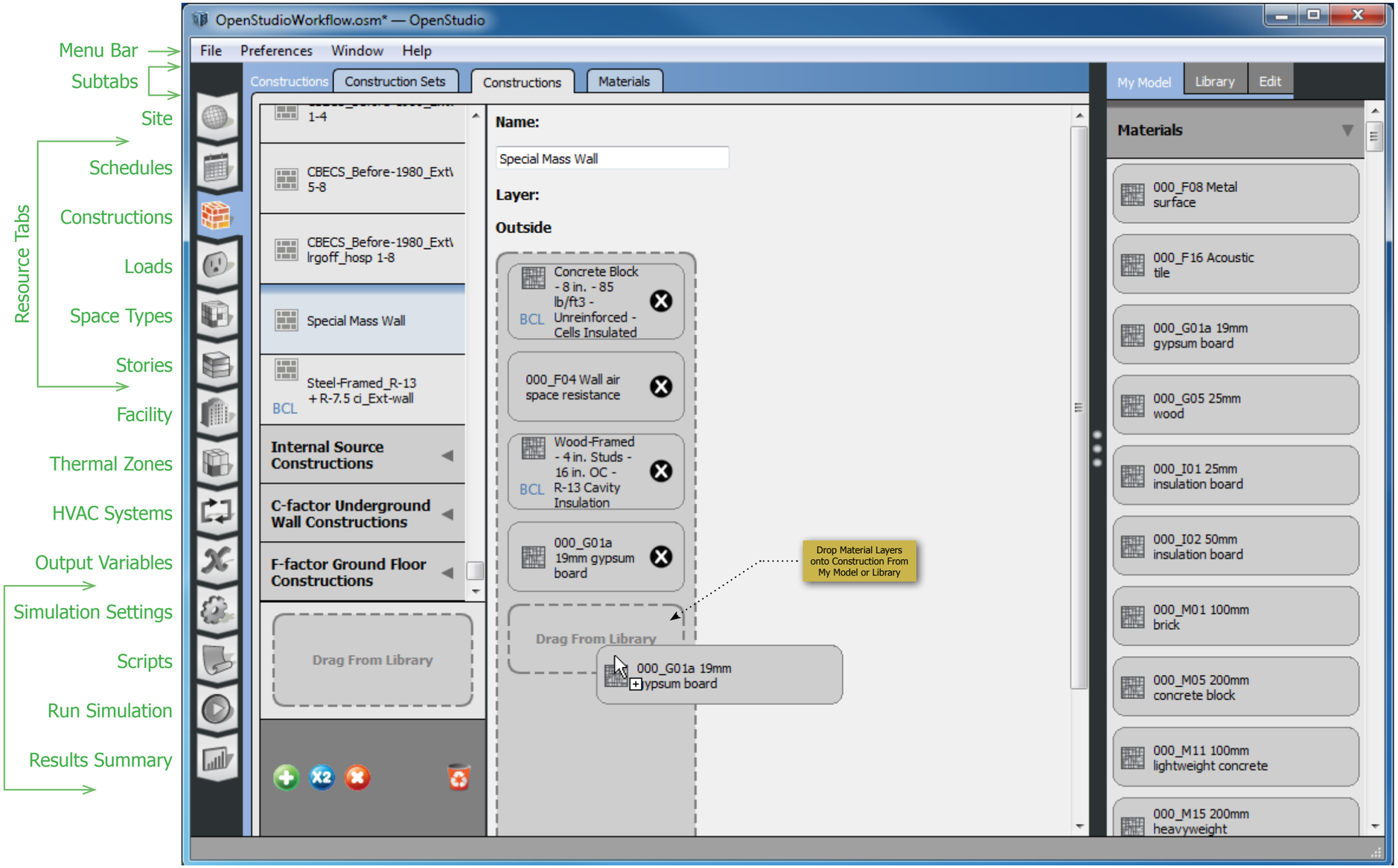
Constructions - Constructions

Notes

The Constructions subtab lists construction objects that are in your model. You can drag additional constructions here from the library. Constructions download using the Online BCL window will appear in the library with a "BCL" flag.

A construction consists of one or more material layers. You can add materials by dragging them from My Model or the Library to the drop zone. You can only add new materials to the bottom which represents the inside of the wall. You can delete any material by clicking the "x" next to the name.



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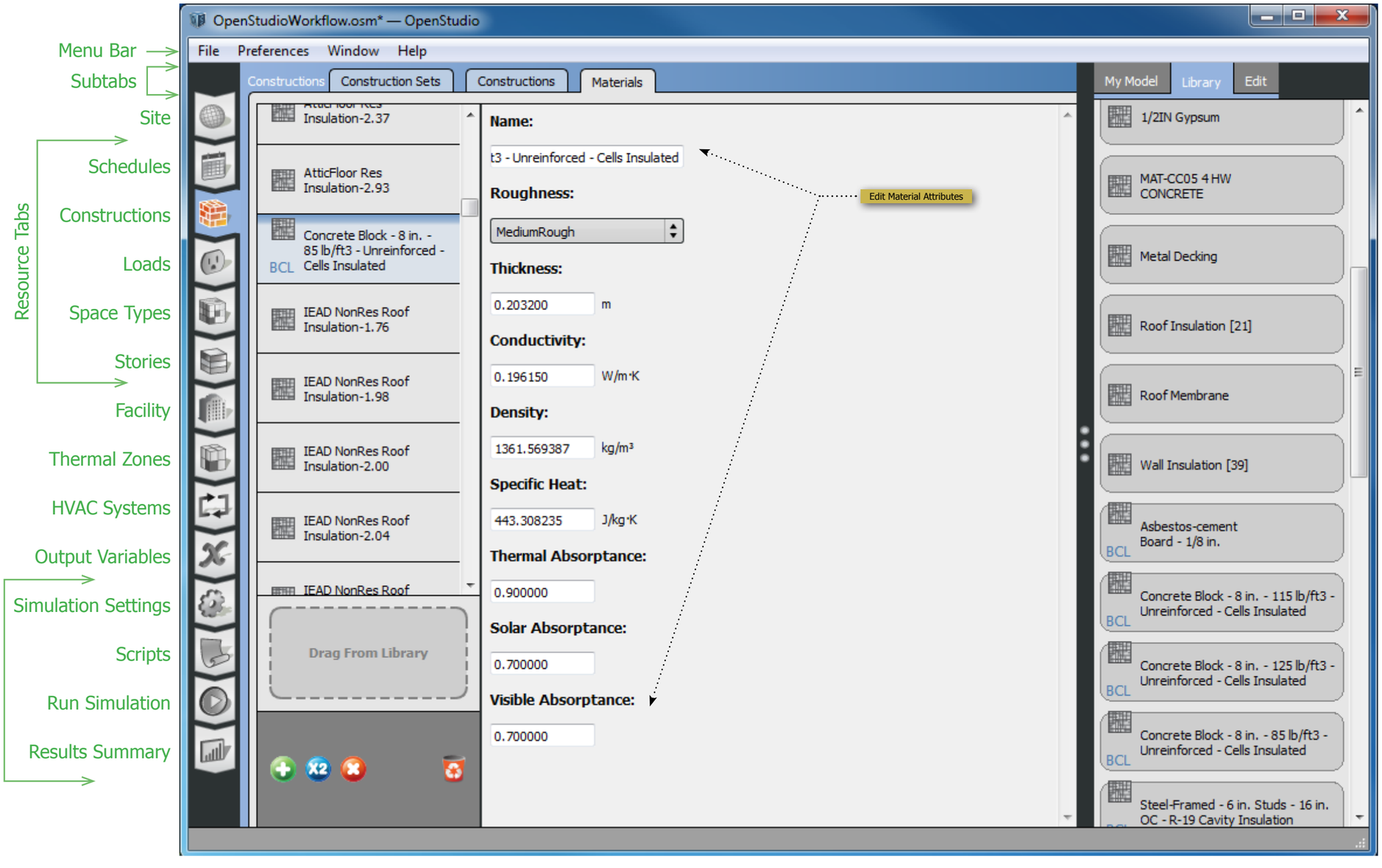
Constructions - Materials

Notes

Constructions are made of one or more layers of materials. The Materials subtab lets you inspect and edit those materials.

There are various classes of material objects. When you add a new material, first select the heading for the type of material you want to add and then click the "+" icon at the bottom of the left pane.

Different types of material will have different data fields available.



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Loads

Notes

The Loads tab contains internal load objects. The fields in the body will change appropriately when you pick a different type of load.

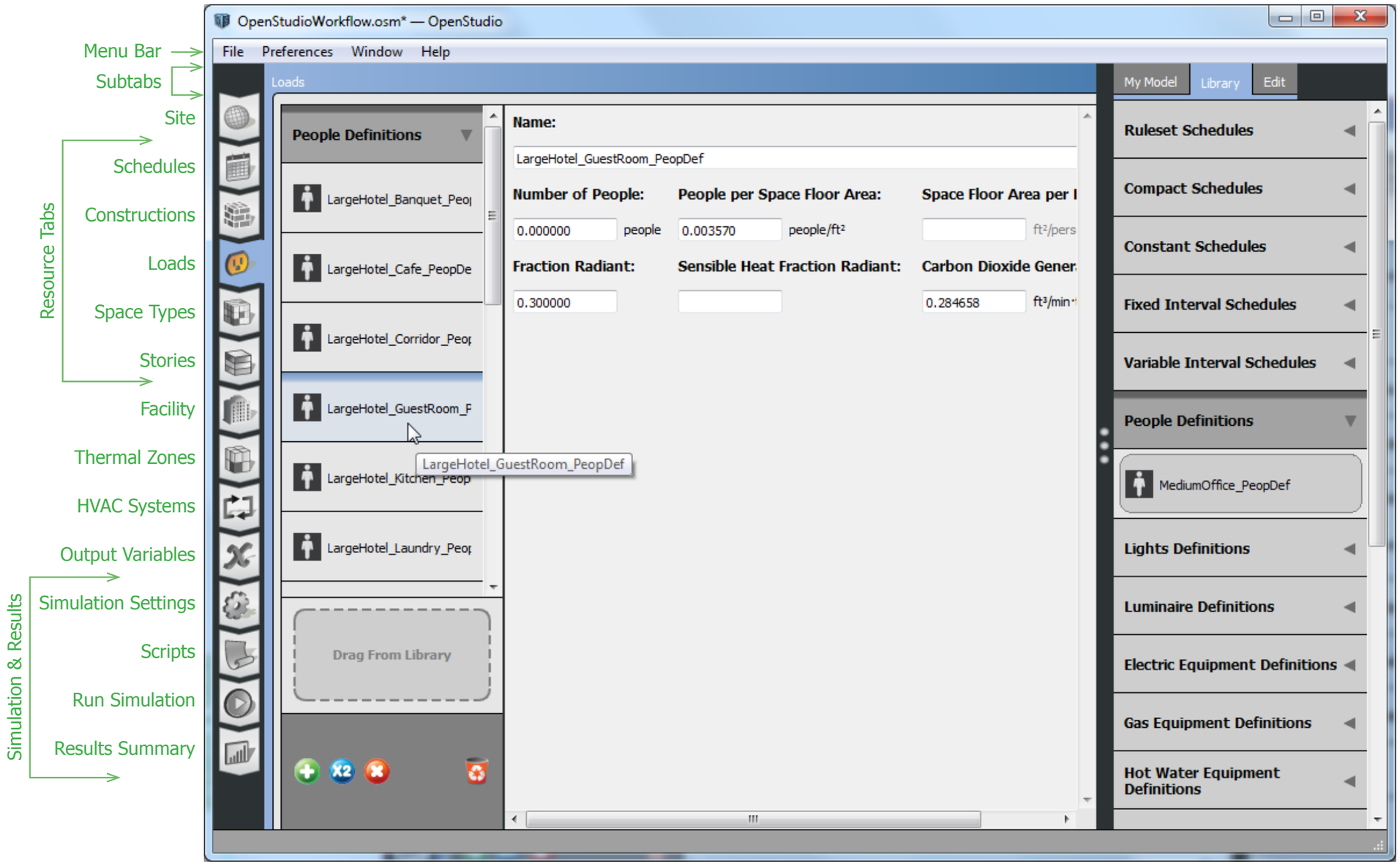
You can assign loads to a space type or directly to a space, except for Water Use Equipment.

The types of loads that can be added in this tab follow.

- People
- Lights
- Luminaires
- Electric Equipment
- Gas Equipment
- Steam Equipment
- Other Equipment
- Internal Mass
- Water Use Equipment

Internal mass is different than the other loads in that it does not use fuel; rather, it stores heat and then dissipates the heat over time. The inputs require a surface area assigned to a construction object.

Water Use Equipment is also unique in that it takes schedules, and is not part of a space type. Water Use Equipment is applied in the HVAC Systems Tab



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Space Types

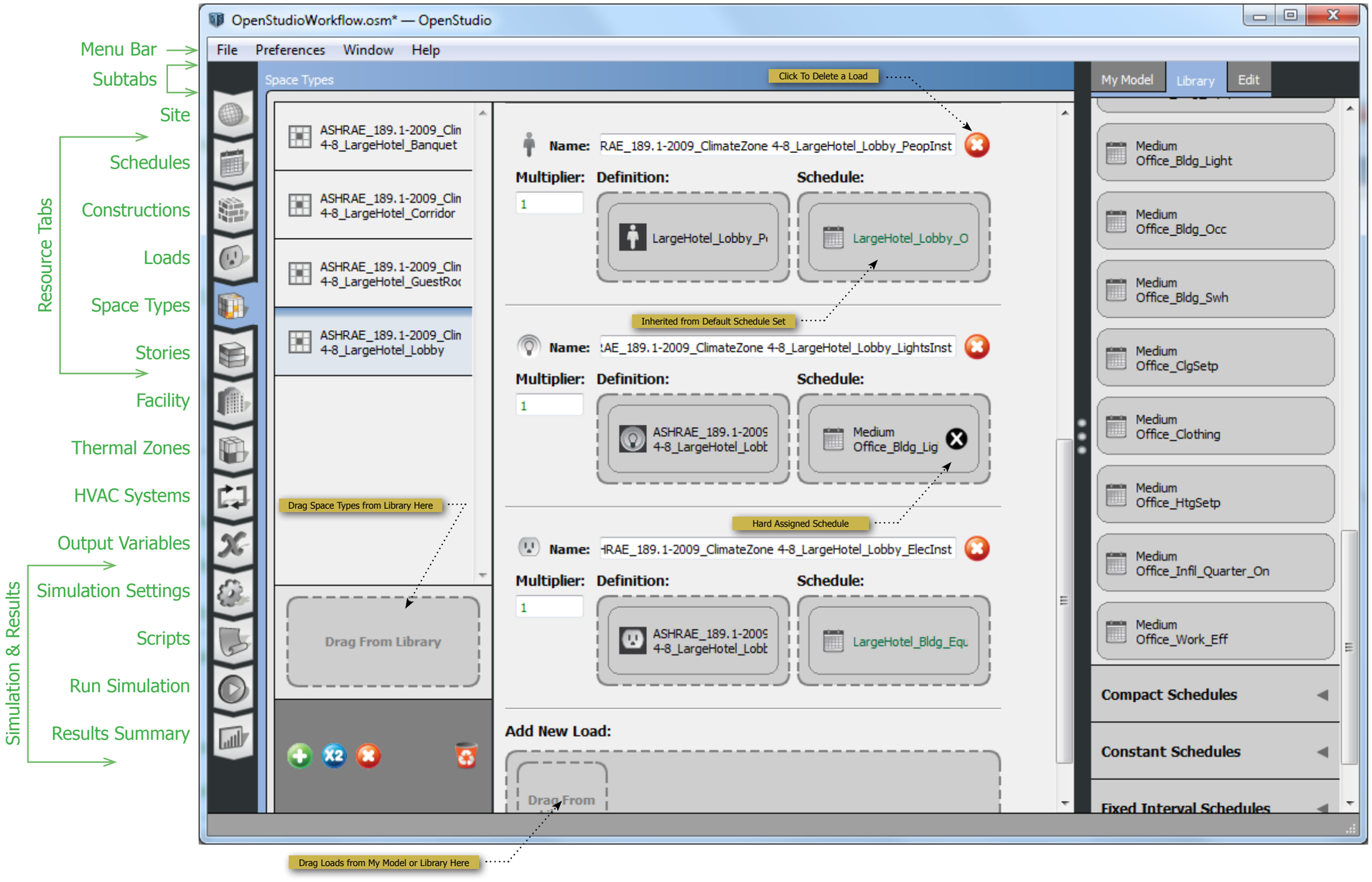
Notes

Space types are the work horses of the resources in OpenStudio. Space types can define internal loads, schedule sets, and construction sets.

Space types define specific spaces or groups of specific spaces in your model. The spaces inherit all objects of the space type. If you redefine a space type, or an underlying object, it will affect all spaces using that space type.

If you scroll down to the bottom of the body in the Space Type tab, you will see a drop zone to create new loads. You can have multiple loads of the same type.

The space types define loads such as lighting or electric equipment as simple area weighted power densities (e.g., W/ft^2). However, you can add loads in several possible ways. For example, a space type could contain multiple types of lighting. You might define one lighting load for general lighting using a W/ft^2 and then add another lighting load for decorative lighting using another W/ft^2.



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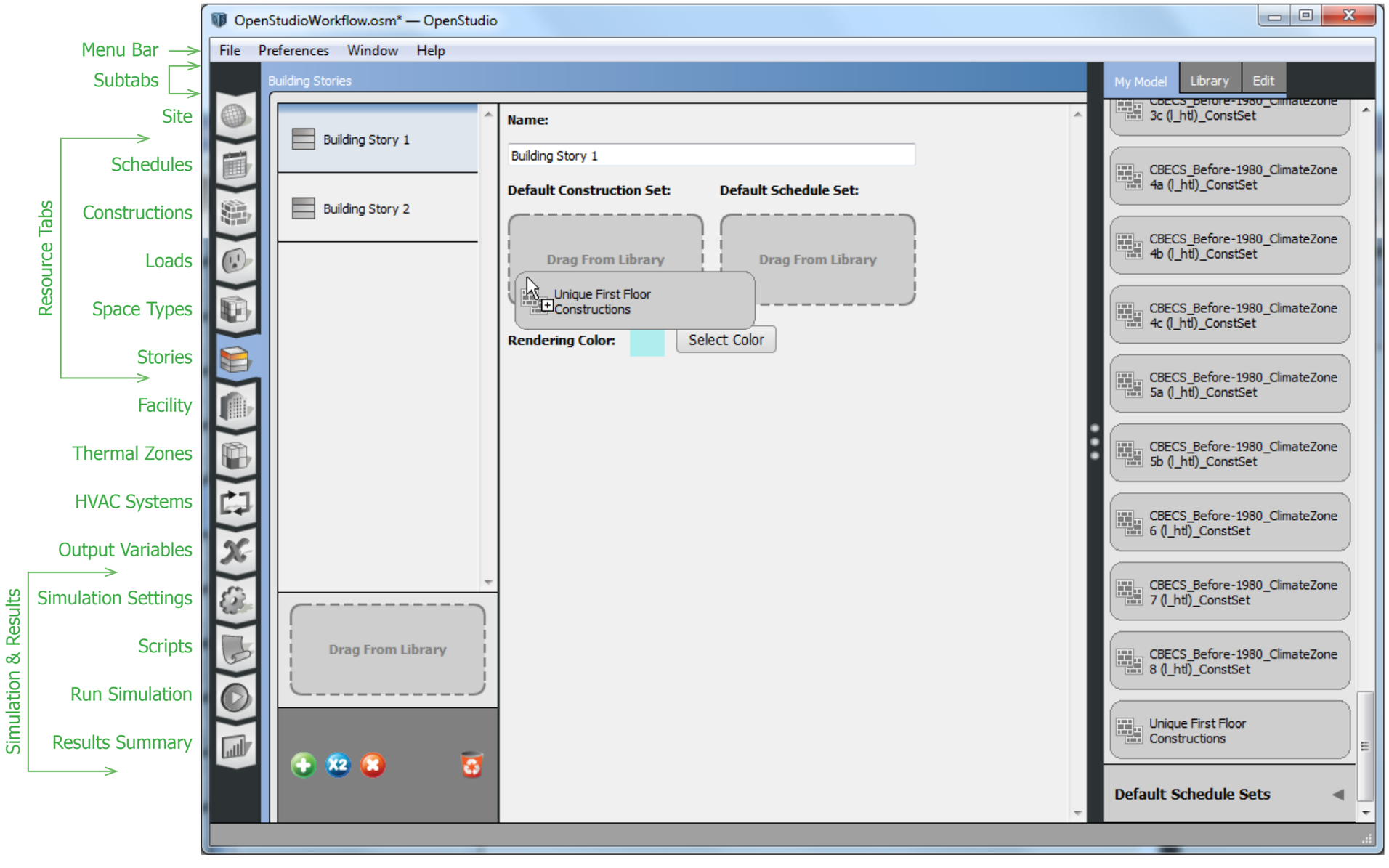
Building Stories

Notes

A Building Story is a container that can hold a collection of space objects. This can be used to change constructions or schedules based on the building story.

You can also use the story assignments to generate reports that summarize data by story.



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Facility

Notes

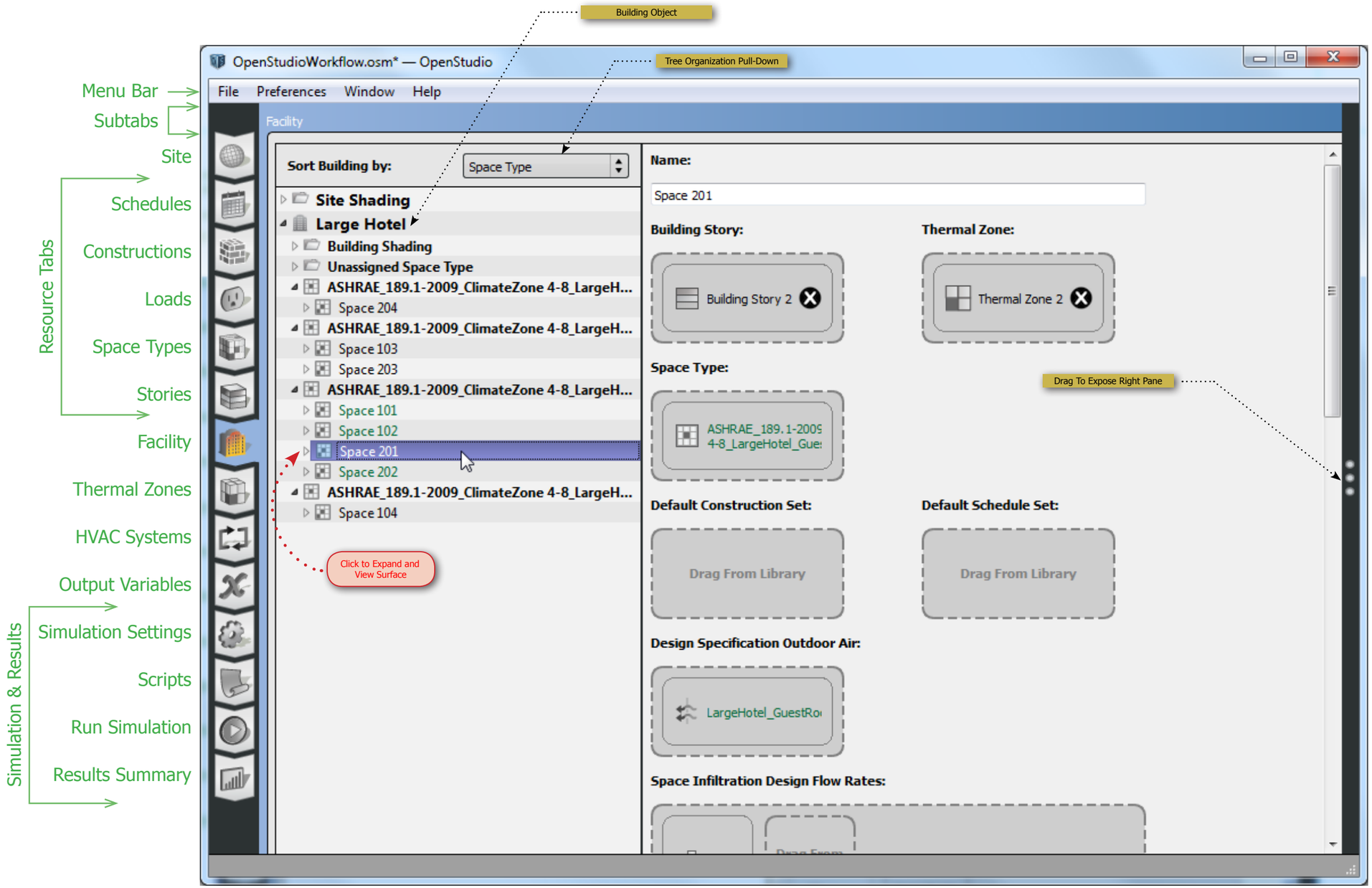
The Facility tab serves a number of functions. First, it allows you to see a hierarchical tree of your model. This tree can be organized by building story, thermal zone, or as shown here, space type.

If you are viewing the tree by space type, and a space does not have a space type assigned, it would appear under Unassigned Space Type. A similar pattern is followed for Thermal Zone and Story.

The Facility tab is also where you can select spaces and assign a building story, thermal zone, and space type. This is also where you can add loads to a space. These loads would be on top of loads inherited from the space type.

You can also drill down to inspect individual surfaces or subsurfaces.

Lastly, it lets you pick the Building object. This contains top level construction, schedule, or space type assignments, and sets the rotation for the building.



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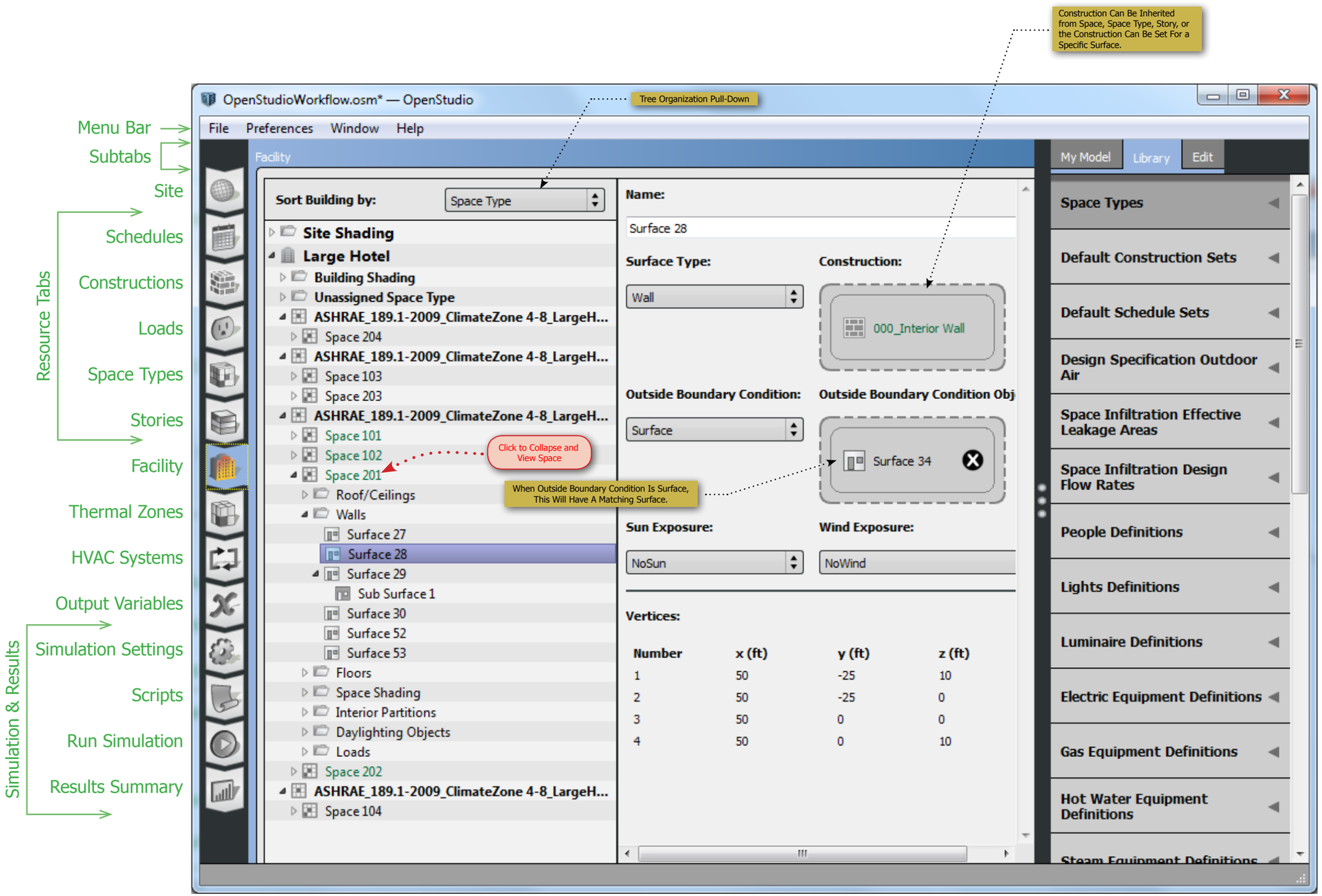
Facility

Notes

This screenshot of the Facility tab shows a surface selected.

Although you will generally work with the SketchUp Plug-in to define the building envelope, having a surface or subsurface selected in the Facility tab will allow you inspect and edit most attributes. Only the vertices are locked down.

Spaces and surface cannot be deleted or created. You need to use the SketchUp Plug-in to do that.



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Thermal Zones

Notes

The Thermal Zones tab has four main functions.

1. It allows you to turn ideal air loads on and off. This is a basic way to get heating and cooling load set points without having to define a detailed HVAC system.

2. It allows you to attach zone equipment to your zone, for example a Packaged Terminal Air Conditioner.

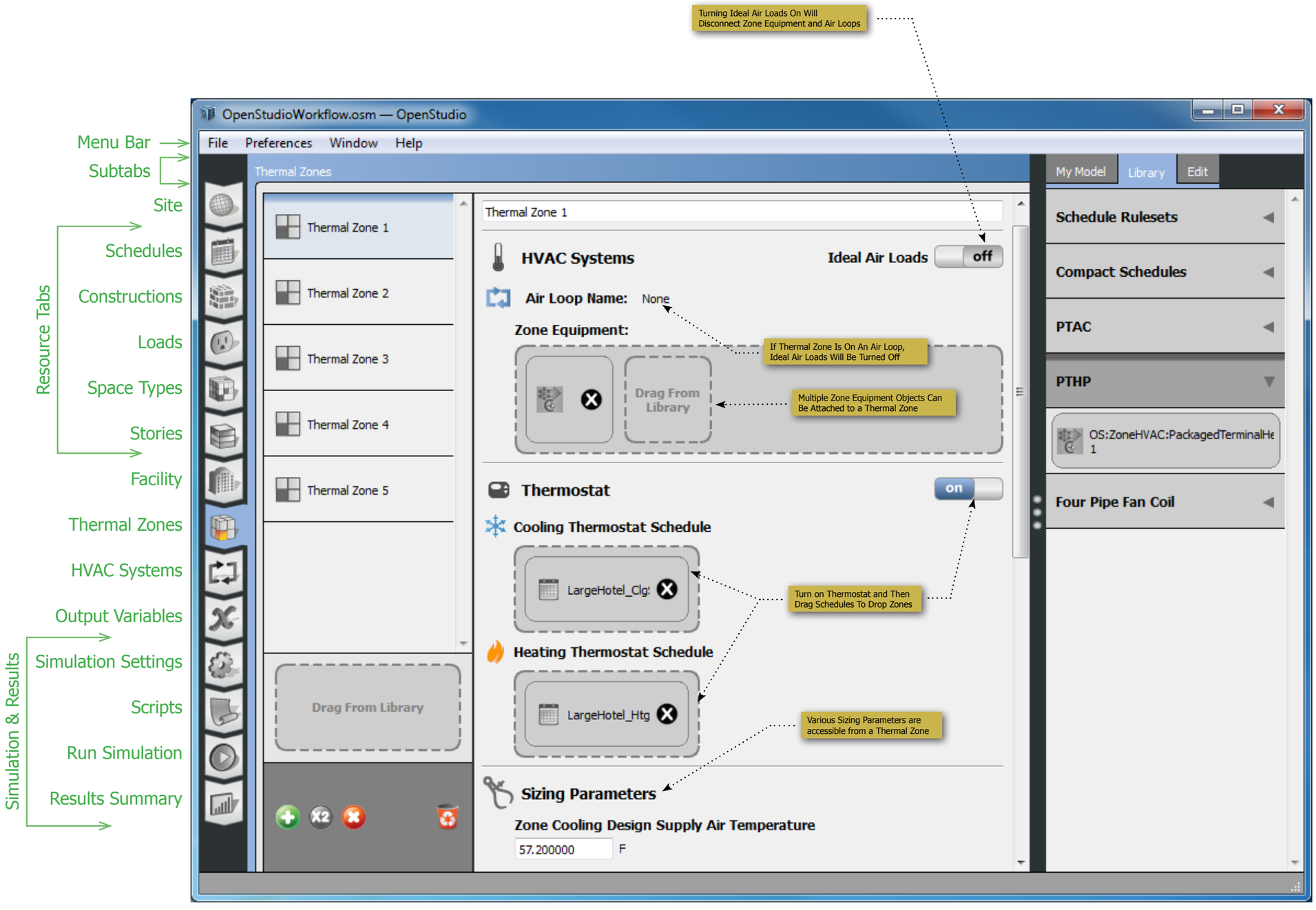
3. It allows you to assign thermostats to your thermal zone.

4. Set Sizing Parameters

If you click on an object in the Zone Equipment drop box, you will be able to inspect it in the Edit tab of the right pane.

Tip

A Thermal Zone can't have ideal air loads on and have an Air Loop or Zone Equipment at the same time. If you try to use both, the previously selected system will be disabled.



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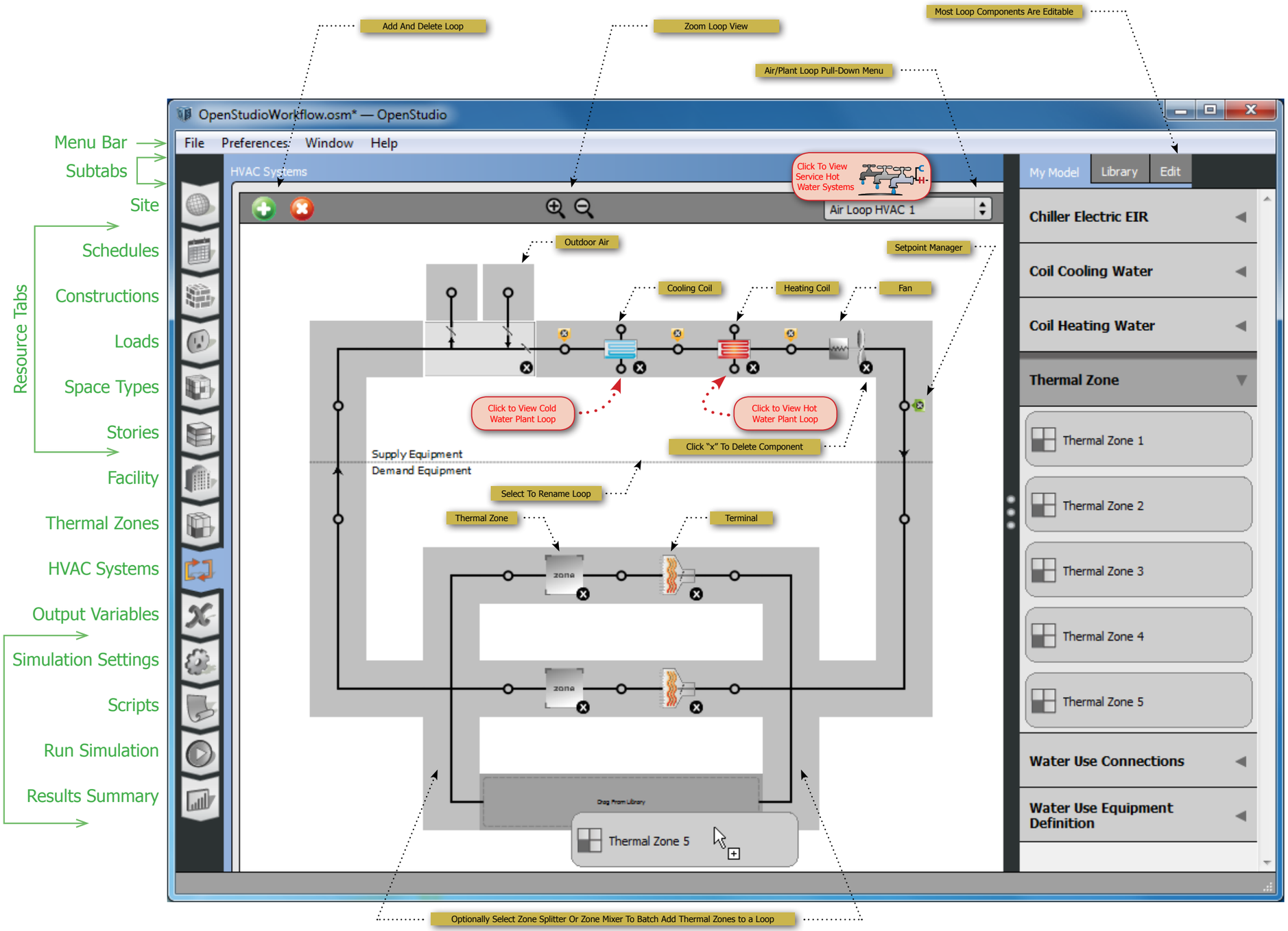
HVAC Systems - Air Loop

Notes

The HVAC Systems tab is used to create, inspect, and edit air and plant loops. The green "+" at the top left is used to add template or empty loops, and the "x" next to it will delete them. The pull-down at the top right of the body is to select which loop to is displayed.

The top half of the loop is for supply-side objects, the bottom half is for demand. Thermal Zones and other objects can be dragged onto drop zones or nodes. Optionally you can select the splitter or mixer to bring up a list of Thermal Zones, checking the ones you want included in the loop.

When adding a template loop, there are four images within the icon. From left to right they represent the type of cooling, heating, fan, and terminal unit, in the template. The example below has cold and hot water, a variable speed fan, and a hot water reheat terminal unit.



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HVAC Systems - Cold Water Loop

Notes

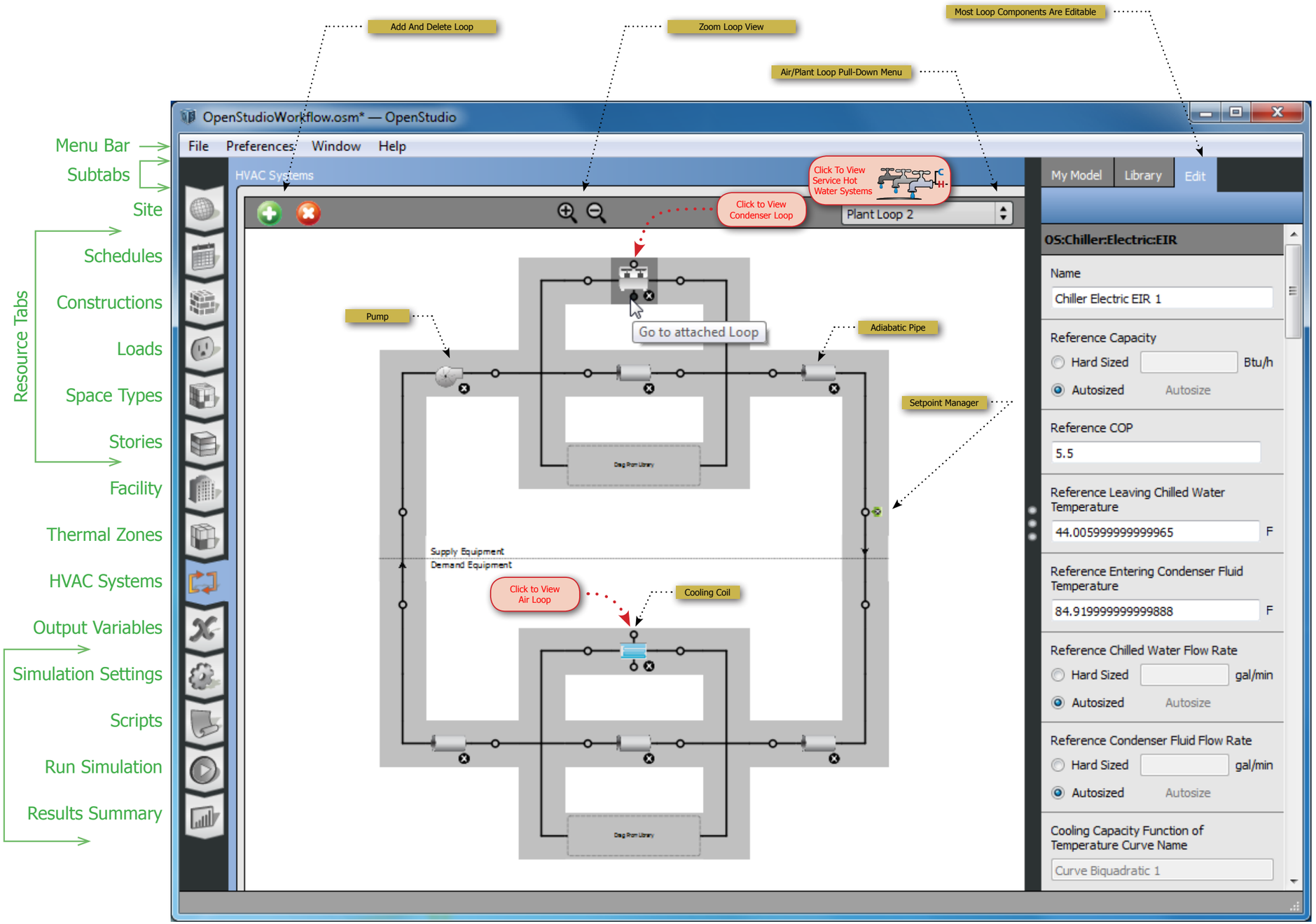
In the cold water loop the cooling coil that had been a supply side object on the air loop is now a demand object.

The supply side has a pump and a water cooled chiller. The adiabatic pipes are a necessary part of the loop. There are no attributes to set for the pipes.

You can click on the chiller to drill down further to the condenser loop. Or you can click on the cooling coil to go back to the air loop.

Resource Tabs

Simulation & Results



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HVAC Systems - Condenser Loop

Notes

In the condenser loop the chiller that had been a supply side object on the cold water loop is now a demand object.

The supply side has a pump and a cooling tower. As with the cold water loop the adiabatic pipes are a necessary part of the loop.

You can click on the chiller to drill to go back to the cold water loop.

Resource Tabs

Simulation & Results

Menu Bar

Subtabs

Site

Schedules

Constructions

Loads

Space Types

Stories

Facility

Thermal Zones

HVAC Systems

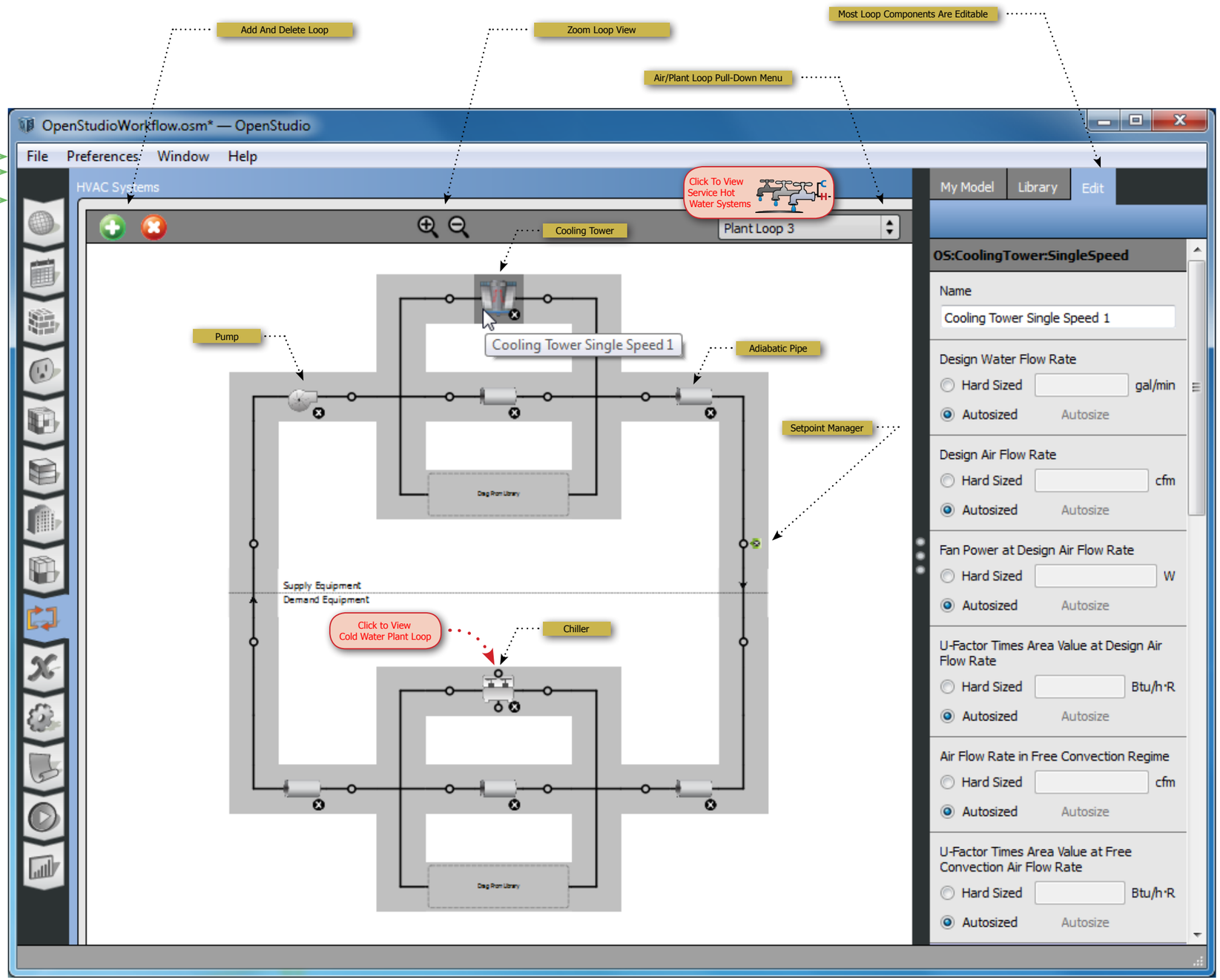
Output Variables

Simulation Settings

Scripts

Run Simulation

Results Summary



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HVAC Systems - Hot Water Loop

Notes

In the hot water loop the heating coil that had been a supply side object on the air loop is now a demand object.

The supply side has a pump and a boiler. The boiler can use a variety of fuels. The adiabatic pipes are a necessary part of the loop. There are no attributes to set for the pipes.

You can click on the heating coil to go back to the air loop.

The heating coils without links represent the reheat terminals for each connected Thermal Zone.

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Thermal Zones

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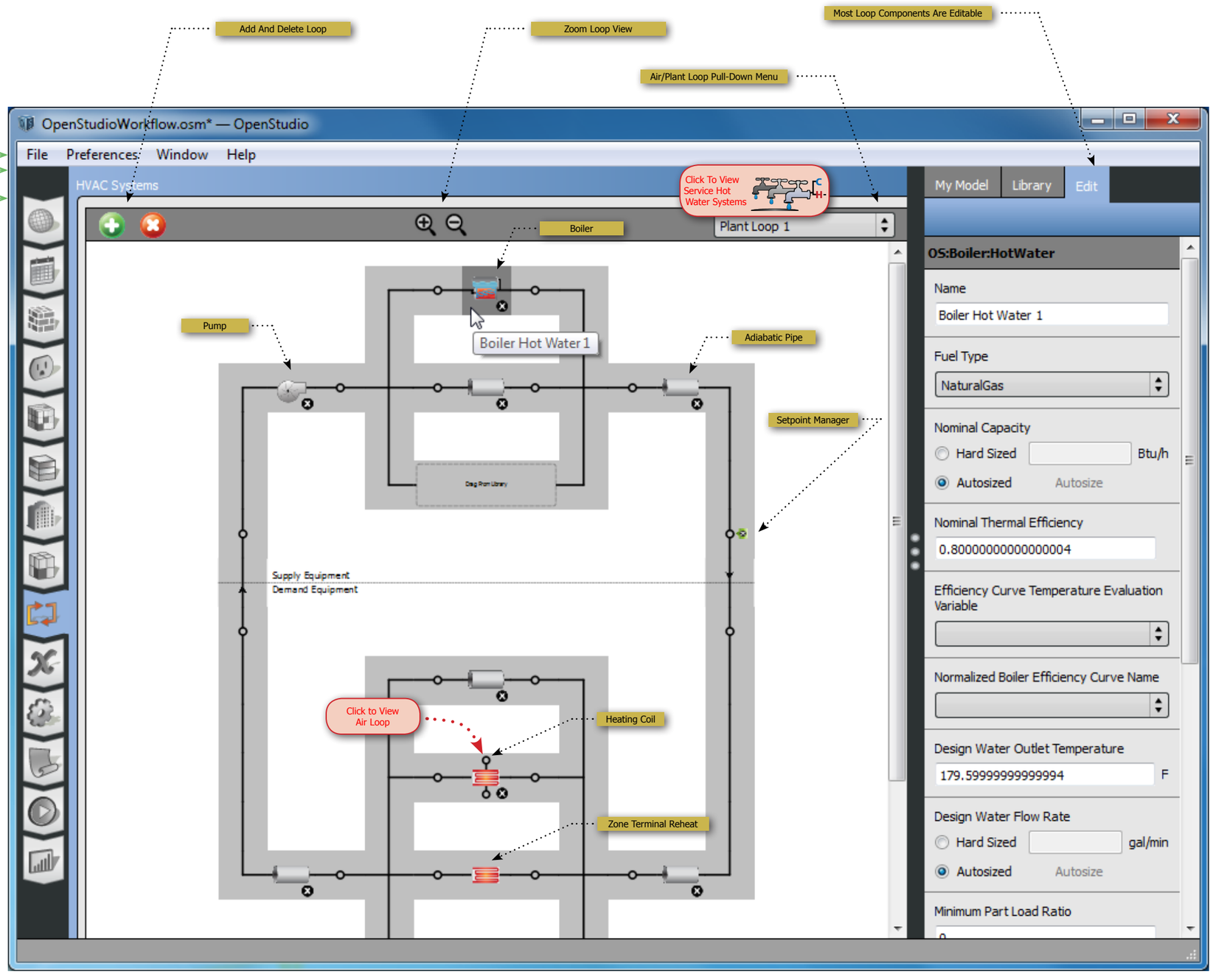

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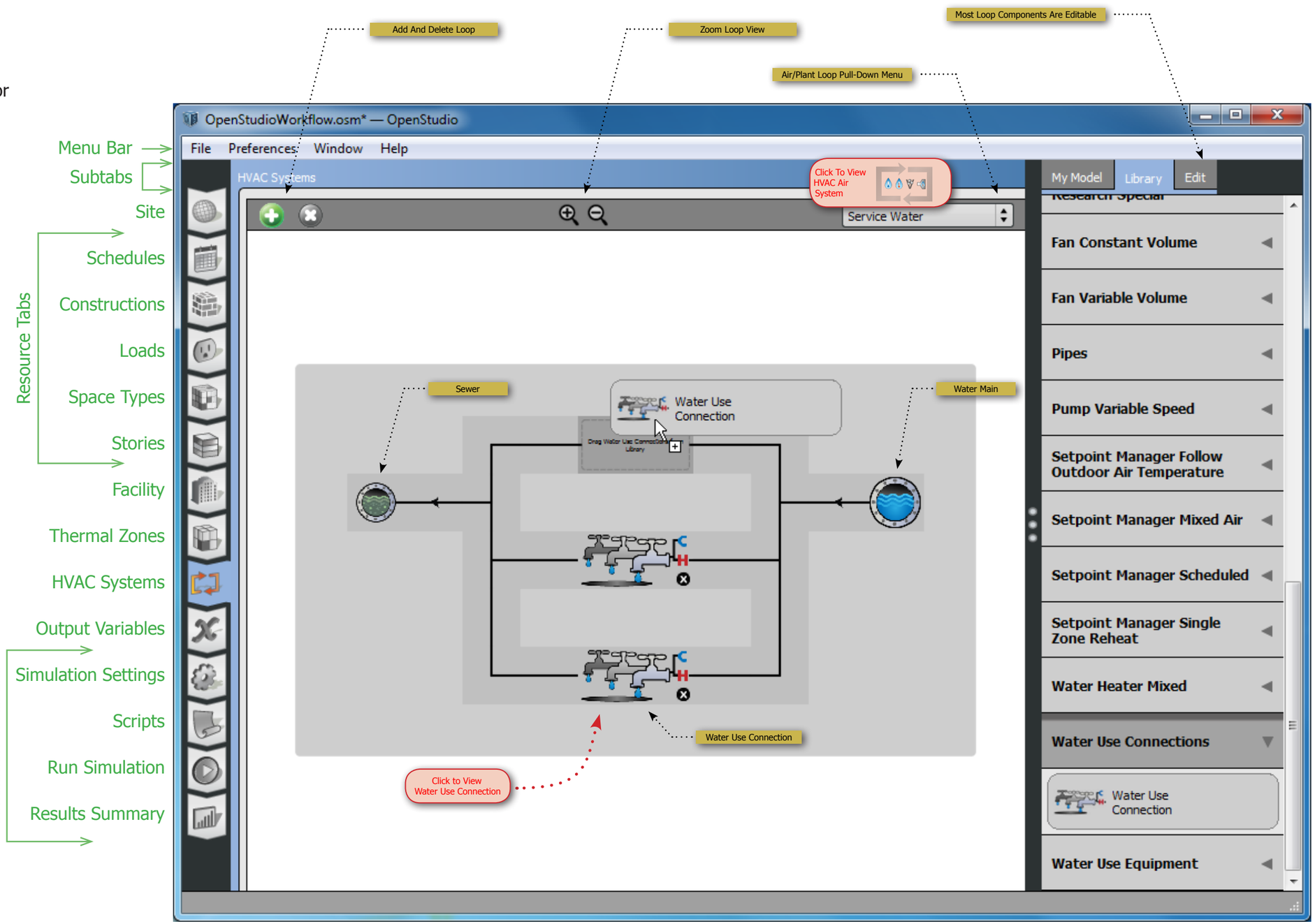
HVAC Systems - Water Mains Editor

Notes

New to OpenStudio 0.9.0 are tools to model service hot water. The first view into the HVAC tab will be the water mains editor, which shows as "Service Water" on loops pulldown list.

Water enters the system at the right and leave at the Sewer on the left. One or more water use connections can be added in the middle.

Clicking a water use connection will take you to a model window where you can add water use equipment.



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HVAC Systems - Water Use Connection

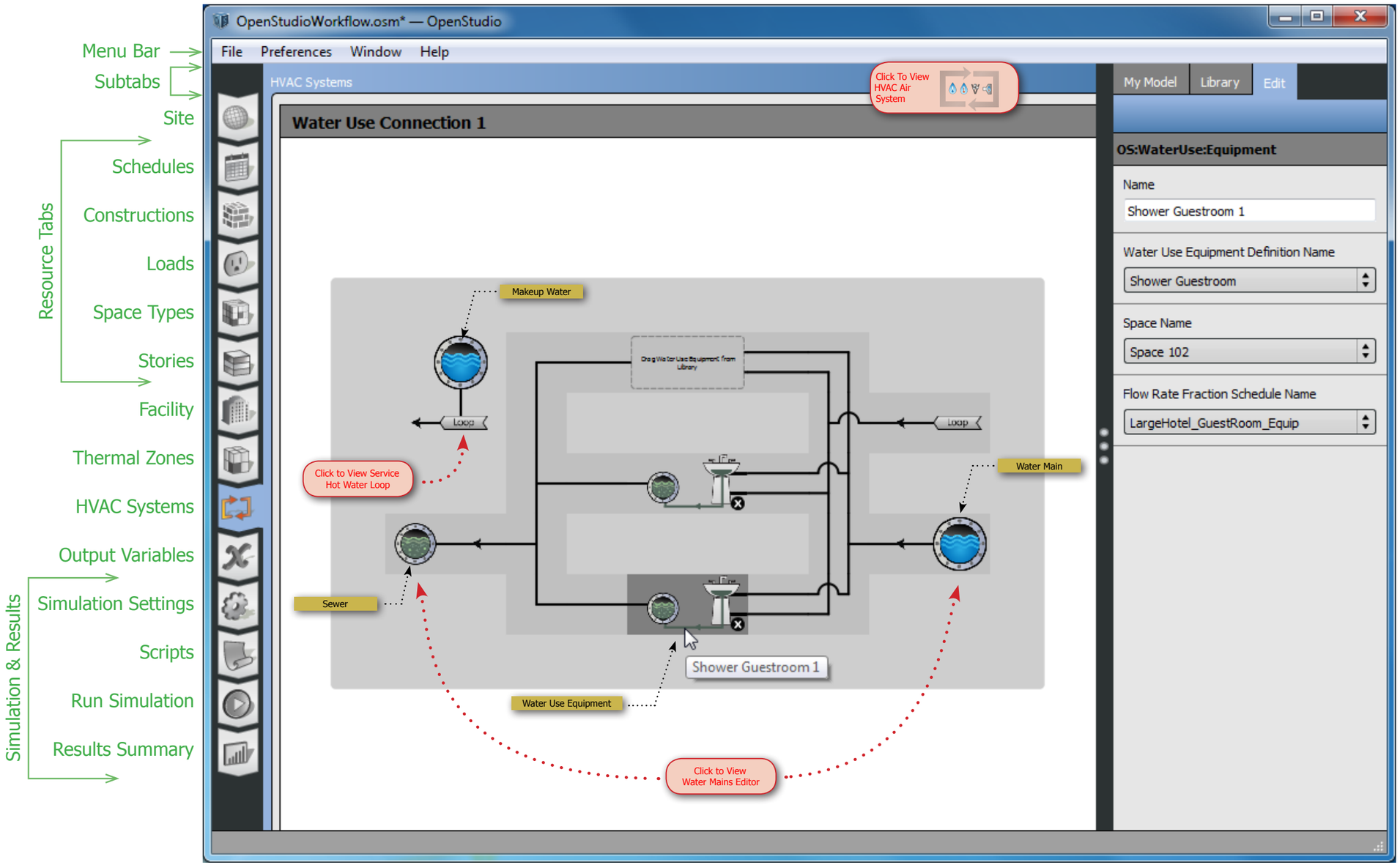
Notes

Dragging a water use equipment object into the water use connection will create an instance of that definition. Much like lights, people and other loads, there is a fractional schedule to define usage patterns.

Optionally you can associate the equipment with a space. There is no direct energy use to the space, but heat from the equipment will be added to the space.

The equipment can be anything that uses water, hot or cold. The definition contains a peak flow rate and a target temperature schedule. Hot and cold water will mix to reach the target temperature at the fixture.

Click the water main, sewer, or makeup water to go back to the water mains editor. If you have a plant loop associated with the water use connection the "Loop" button will take you to the loop.



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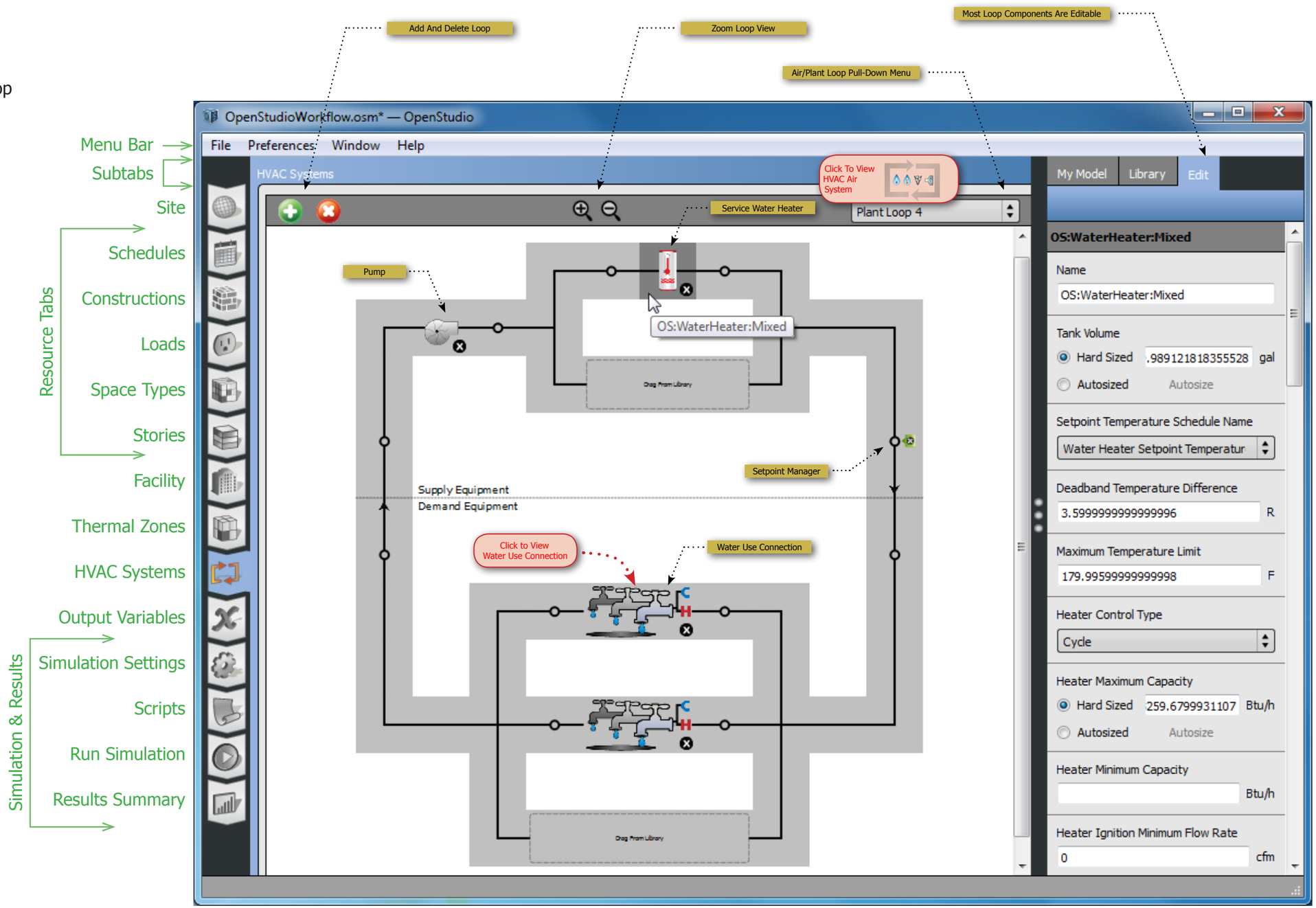
HVAC - Service Water Heater Loop

Notes

The service water heater loop starts off just like any other plant loop, but unlike the ones serving an air loop, this plant loop as water use connections on the demand side, and a hot water heater, vs. a boiler on the supply side. A pump and setpoint manager are also necessary.

Both the hot water heater and the setpoint manager require a temperature schedule. Generally these should use the same schedule, which should have a temperature high enough to meet the setpoints at the water use equipment objects.

The energy that goes into the hot water heater will show up in the results page as "Water Systems". The pump is not included in this. The results page does not show water usage, but you can look at the Annual Building Utility Performance Summary (ABUPS) report in ResultsViewer to see water usage.



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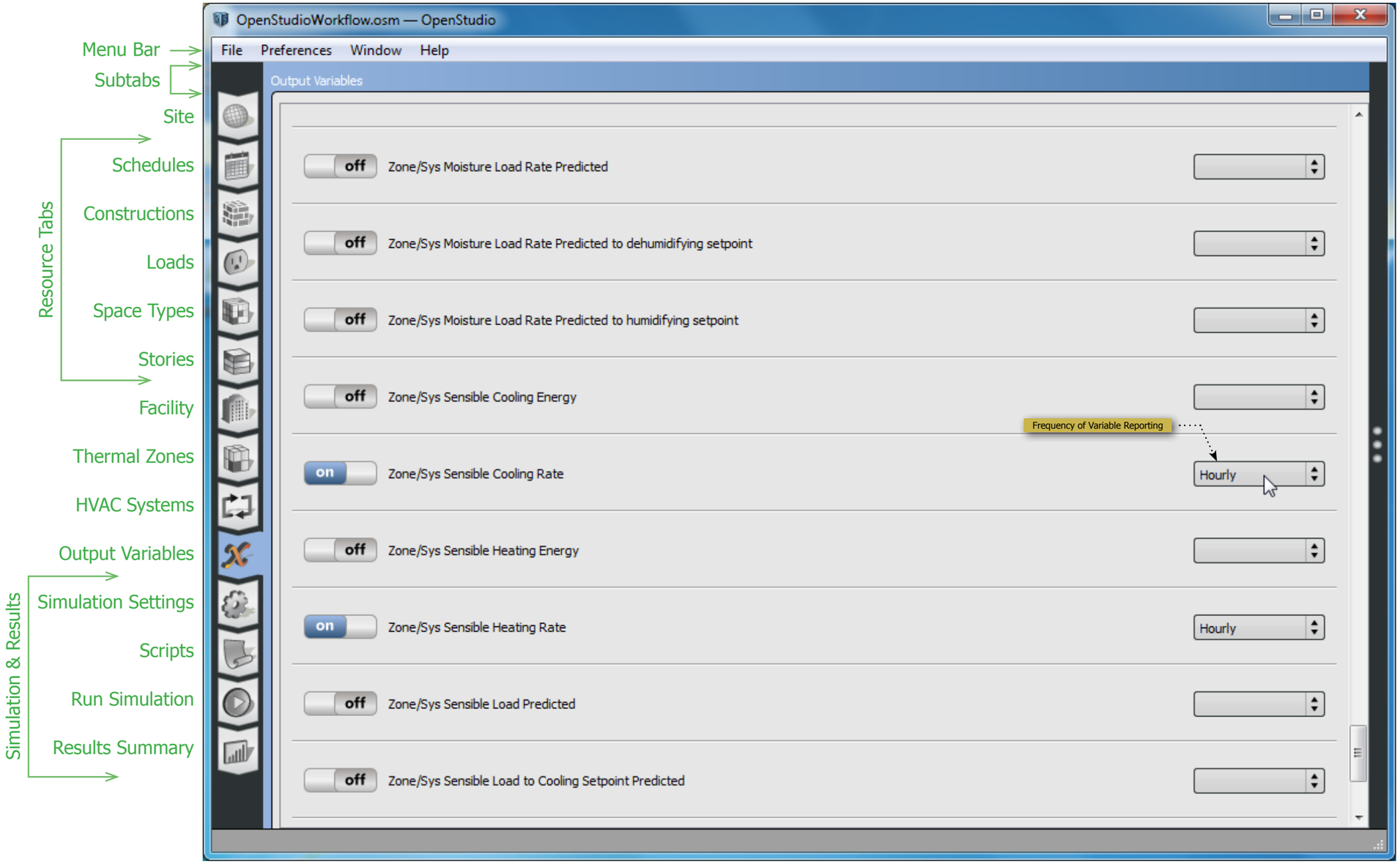
Output Variables

Notes

The Output Variables tab creates a list of variables based on the type of objects you have in your model. You can then turn them on or off and set the frequency of reporting.

These variables populate the SQL file generated by EnergyPlus with annual time series results data. You can view them in ResultsViewer. The Results Summary tab in this application is not affected by the variable requests.

It will not offer a comprehensive list of variables. If you want to add a variable that is not here or name a specific object to report, you can accomplish this by injecting raw IDF text in the Scripts tab.



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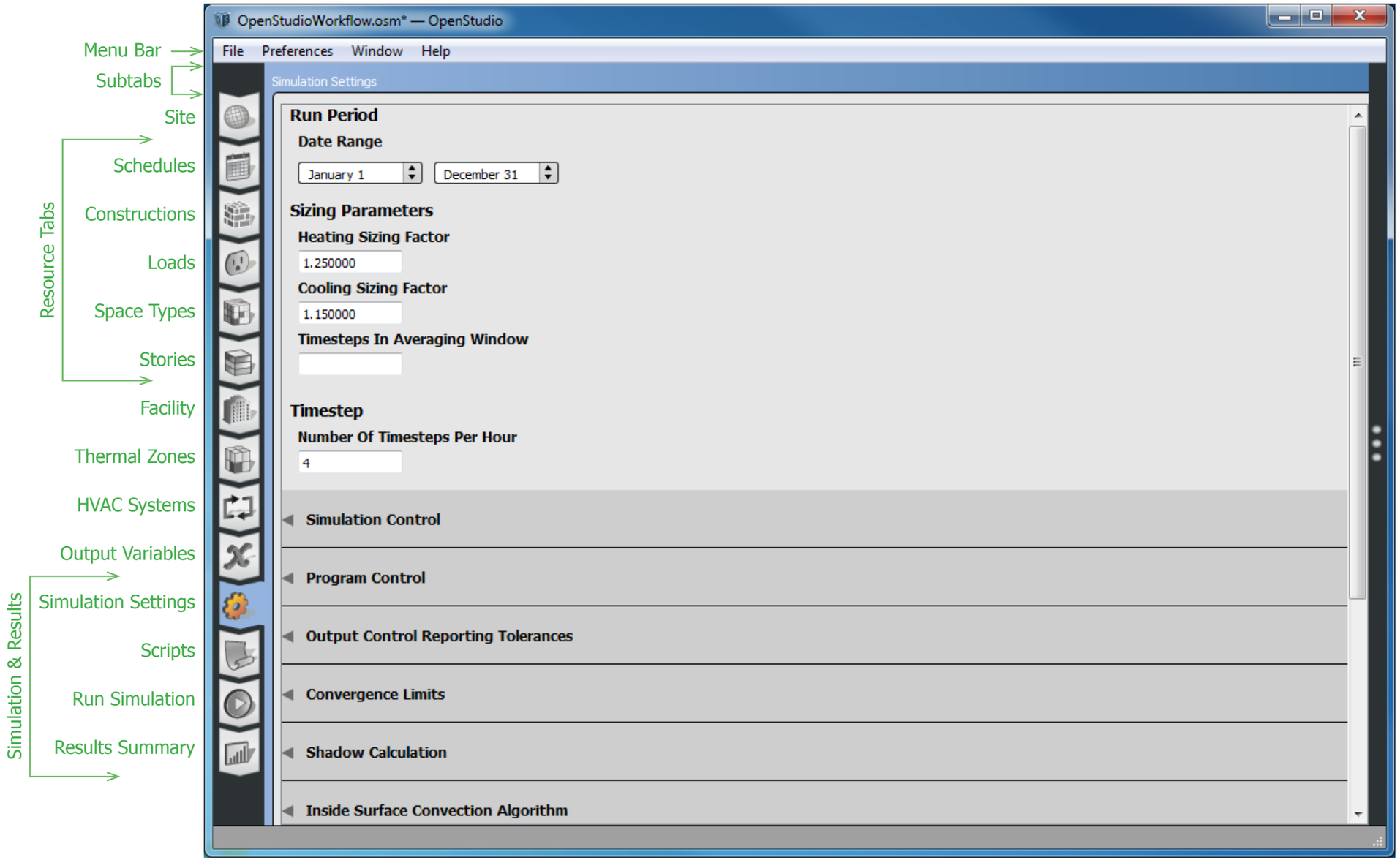
Simulation Settings

Notes

The Simulation Settings tab lets you inspect and customize many of the simulation settings used by EnergyPlus. Soon Radiance configuration settings will also be added. Below is a list of settings included in OpenStudio 0.10.0.

- RunPeriod
- SimulationControl
- SizingParameters
- ProgramControl
- Timestep
- OutputControlReporting-Tolerances
- ConvergenceLimits
- ShadowCalculation
- SurfaceConvectionAlgorithmInside
- SurfaceConvectionAlgorithmOutside
- HeatBalanceAlgorithm
- ZoneAirHeatBalanceAlgorithm
- ZoneAirContaminantBalance
- ZoneCapacitanceMultipleResearchSpecial



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Scripts

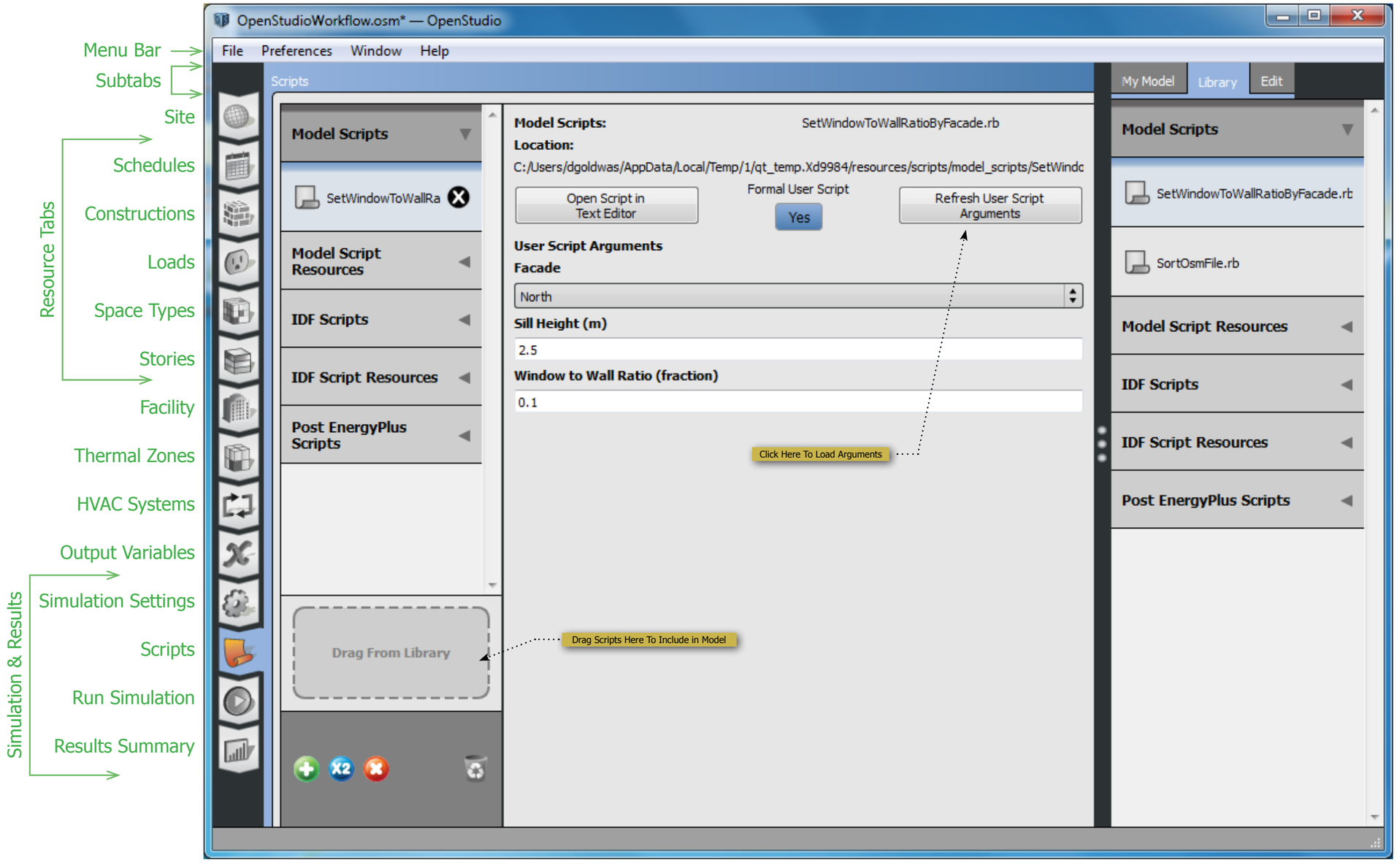
Notes

The Scripts tab is a very powerful tool that allows you to extend the functionality of OpenStudio. To use this tab you need to have Ruby installed on your machine. Ruby is not automatically installed as part of OpenStudio. The OpenStudio website has instructions for installing ruby on Windows and Linux. Mac has Ruby installed by default.

An important thing to understand about the Scripts tab is when scripts can be run in the simulation workflow. The normally workflow for running a simulation is to convert the OSM (OpenStudio Model) to an IDF (Input Data File), then that IDF is handed to EnergyPlus to run a simulation.

Model scripts are run on the OSM model before it is converted to an IDF. IDF scripts are run on the IDF file before it is handed to EnergyPlus, and Post EnergyPlus scripts are run after the EnergyPlus simulation.

Some scripts such as the example shown here take arguments. These arguments and the scripts are saved alongside your OSM file.



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Run Simulation - Output

Notes

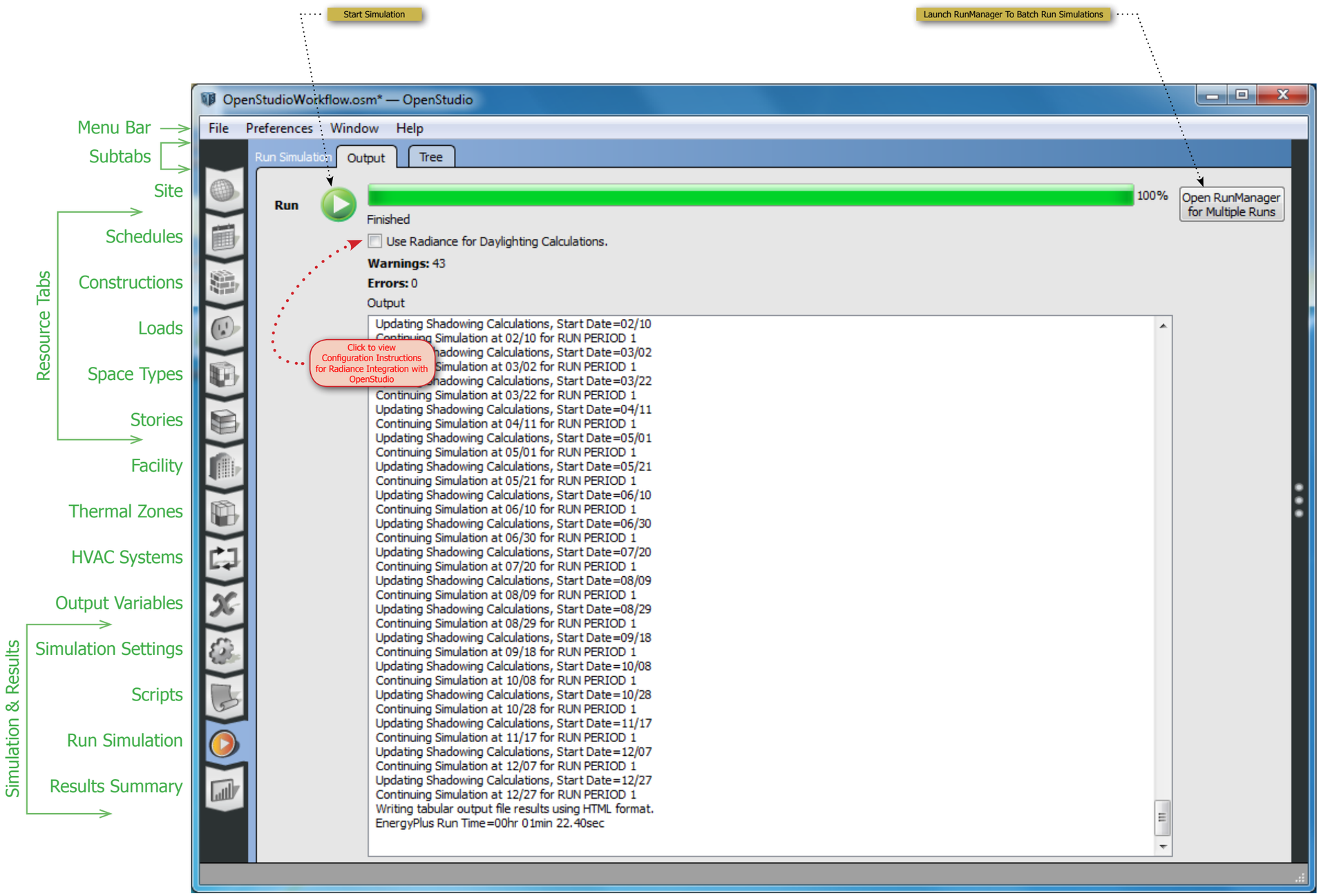
The Run Simulation tab is used to run a simulation. Clicking the green arrow starts the simulation. When the progress bar reaches 100% it is done.

New to OpenStudio 0.9.0 is a check box to use Radiance for daylighting calculations. Using Radiance within OpenStudio requires installation of a number of other tools. Look on OpenStudio for videos (coming soon) demonstrating a workflow for using Radiance.

The output windows shows standard output that you can look at to follow the simulation's progress.

If you want to run multiple jobs at once, there is a button to launch the standalone RunManager application.

Click the Tree subtab in the screenshot to the right to see the RunManager job workflow and to see how to access results files.



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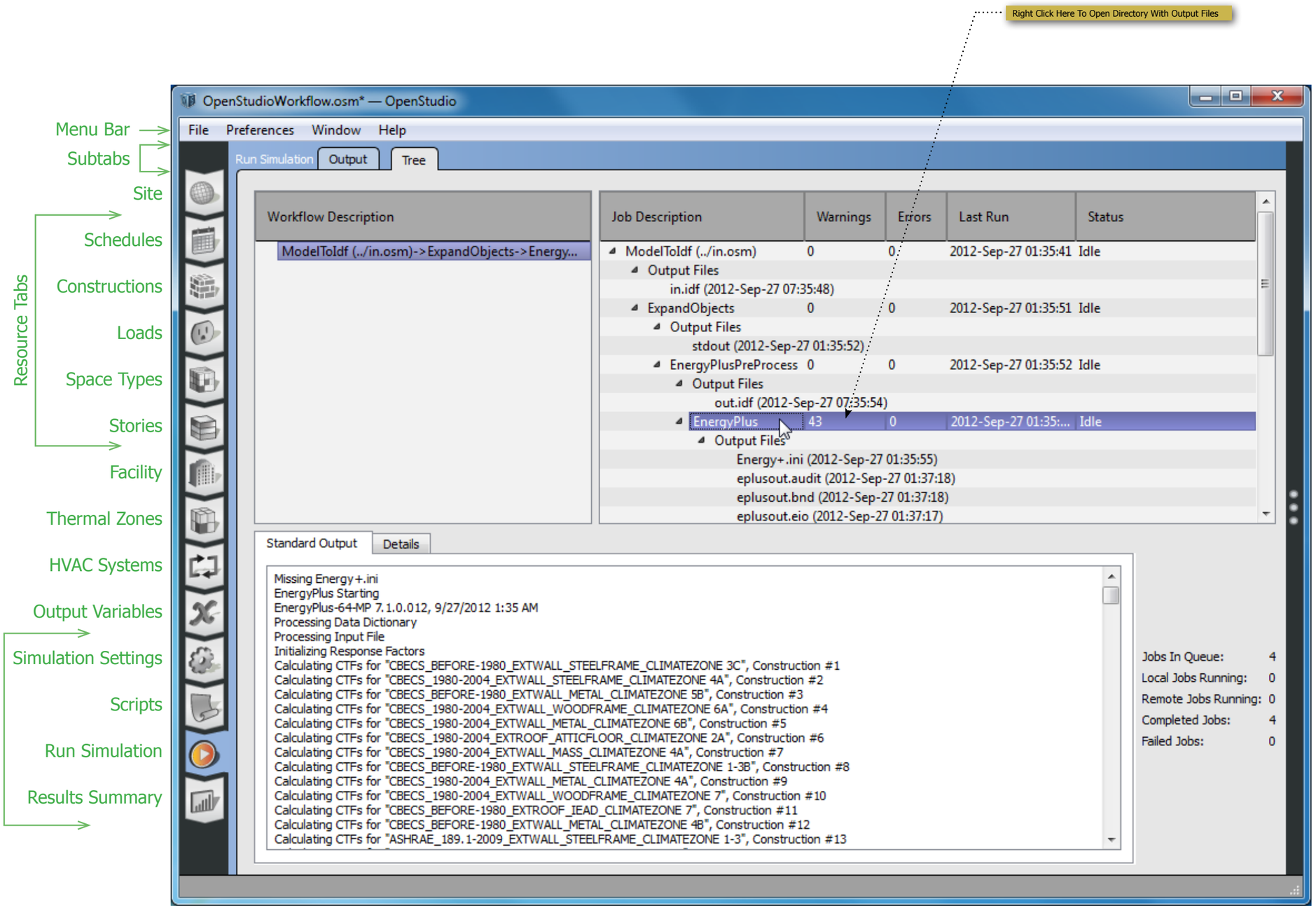
Run Simulation - Tree

Notes

The top right table in the screenshot shows the jobs that ran as part of the simulation run. First was "ModelToIdf". This converted the OSM model to an IDF model.

If you have any Ruby scripts setup in the Scripts tab, they will show on this tree. At the end are a few EnergyPlus jobs, the last of which generated the output files.

You can right click on the EnergyPlus job to open the directory containing the output files.



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Results Summary

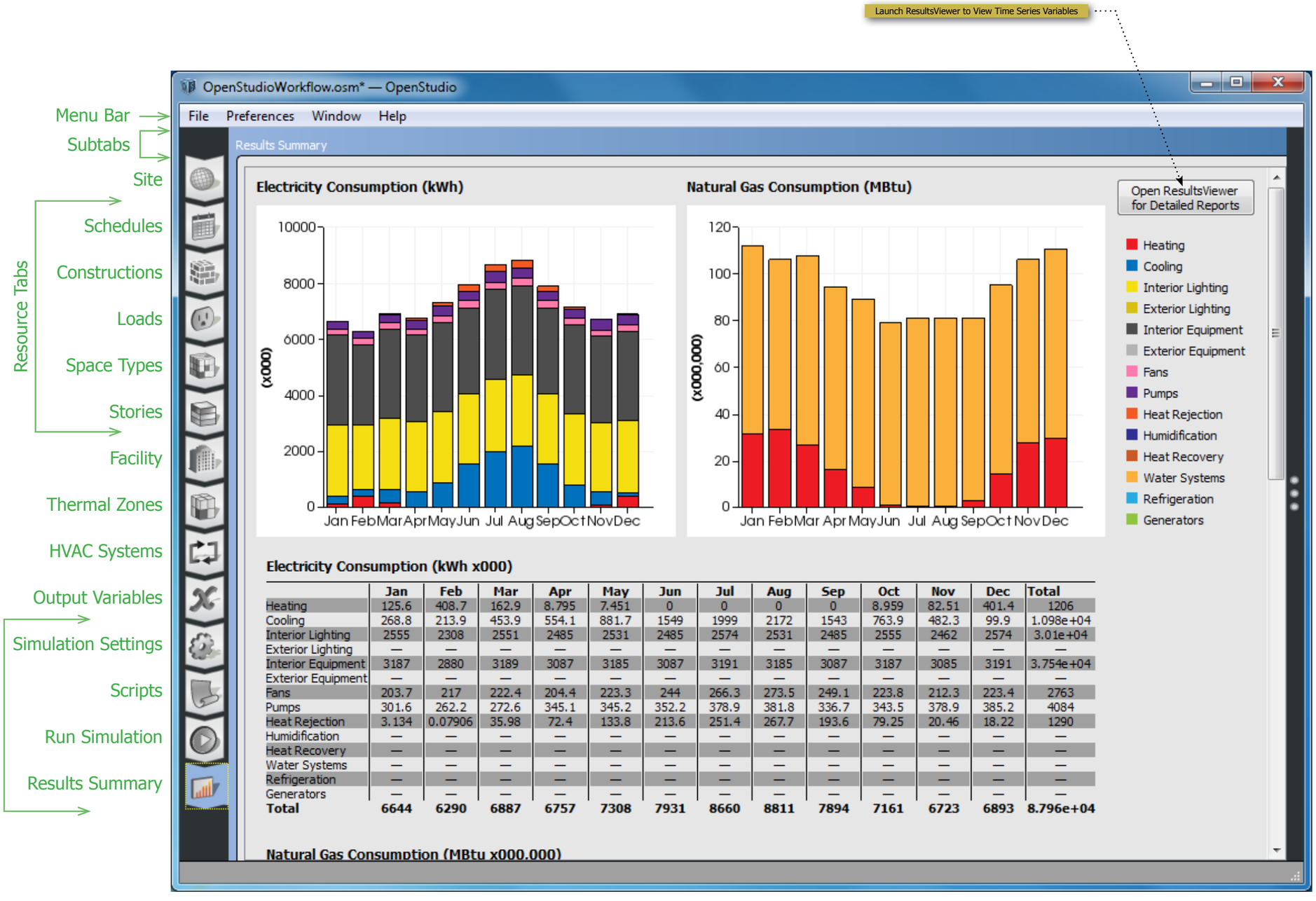
Notes

The Results Summary tab is populated with data after you run a simulation. It displays monthly and annual end use summary data for electricity and natural gas.

It also shows in table form district heating and cooling, which you would use if you ran your model with ideal air loads.

The button at the top right corner of the interface will load the SQL file in the OpenStudio ResultsViewer application. ResultsViewer allows you to create time series line and flood plots for variables that you requested in the Output Variables tab.

When you reopen a previously run simulation, it will populate this tab with previous results.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating	125.6	408.7	162.9	8.795	7.451	0	0	0	0	8.959	82.51	401.4	1206
Cooling	268.8	213.9	453.9	554.1	881.7	1549	1999	2172	1543	763.9	482.3	99.9	1.098e+04
Interior Lighting	2555	2308	2551	2485	2531	2485	2574	2531	2485	2555	2462	2574	3.01e+04
Exterior Lighting	—	—	—	—	—	—	—	—	—	—	—	—	—
Interior Equipment	3187	2880	3189	3087	3185	3087	3191	3185	3087	3187	3085	3191	3.754e+04
Exterior Equipment	—	—	—	—	—	—	—	—	—	—	—	—	—
Fans	203.7	217	222.4	204.4	223.3	244	266.3	273.5	249.1	223.8	212.3	223.4	2763
Pumps	301.6	262.2	272.6	345.1	345.2	352.2	378.9	381.8	336.7	343.5	378.9	385.2	4084
Heat Rejection	3.134	0.07906	35.98	72.4	133.8	213.6	251.4	267.7	193.6	79.25	20.46	18.22	1290
Humidification	—	—	—	—	—	—	—	—	—	—	—	—	—
Heat Recovery	—	—	—	—	—	—	—	—	—	—	—	—	—
Water Systems	—	—	—	—	—	—	—	—	—	—	—	—	—
Refrigeration	—	—	—	—	—	—	—	—	—	—	—	—	—
Generators	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	**6644**	**6290**	**6887**	**6757**	**7308**	**7931**	**8660**	**8811**	**7894**	**7161**	**6723**	**6893**	**8.796e+04**